# MICROPAS7

## USER MANUAL

## V7.1

**September 2005**

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**Water Heating**

A new federal standard for water heaters is already in effect. This changed the standard Energy Factor for a 50-gallon gas water heater from 0.525 to 0.575. This means that the Standard Design is now a 0.575 Energy Factor, with credit accruing only if the Energy Factor is higher.

When a multi-family building has central water heating, the Standard Design will also assume central water heating. Additional information will be required for central water heating that serves multiple buildings.

**Verified Credits**

Many new credits are available that require HERS rater verification and/or diagnostic testing. These are scattered throughout Chapter 2. They include, for example, quality insulation (see ZONE), high EER, airflow, fan wattage, cooling capacity (see COOLING), and buried ducts (see DUCT/DUCT SYSTEM DETAILS).

**Time Dependent Valuation**

One of the key features of the 2005 California standards is the recognition of the impact of on-peak energy use. The methodology is called Time Dependent Valuation (TDV). For many years, the standards have used source energy (kBtu/ft$^2$) as the metric for determining compliance. Source energy multiplies the electrical energy by a factor 3.413*3 where 3.413 is the conversion from kWh to Btu and the factor of 3 adjusts the electrical energy use to account for inefficiencies in the electrical generation and distribution. This factor of 3 is called the source energy multiplier and until the 2005 standards are implemented, has been a constant.

For the 2005 standards, the source energy multiplier is being replaced by a TDV multiplier. This multiplier varies each hour of the year and was derived from the cost of generating and delivering electricity at each hour by California's electric utilities. There is a different TDV hourly file for each climate zone, although the values are similar because the distribution grid is closely connected.

Figure 1-1 shows the hourly TDV values for climate zone 13 for the whole year. This illustrates the summer peaking nature of California's electrical energy use. Figure 1-2 shows the values for an August summer week in climate zone 13 along with the outdoor temperature. This figure shows that high TDV valuations occur on weekdays during warmer hours of the day. Table 1-1 shows the average, maximum and minimum TDV values for all climate zones.

*Figure 1-1. Yearly TDV Values for Climate Zone 13*

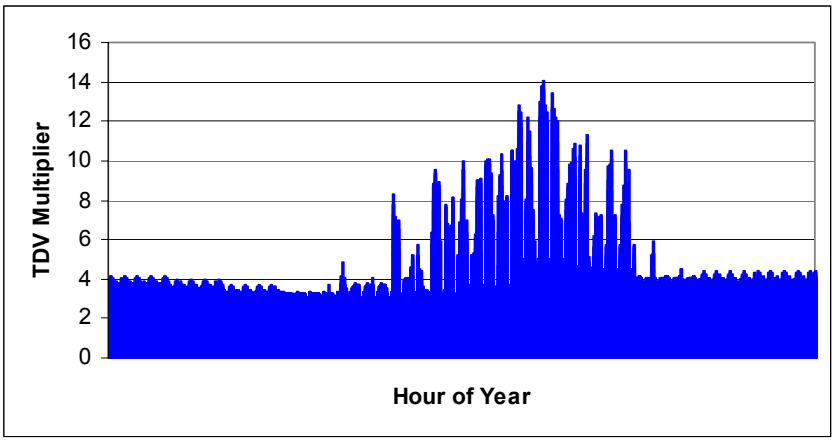

*Figure 1-2. Summer Weekly TDV values for Climate Zone 13 (Sunday – Saturday)*

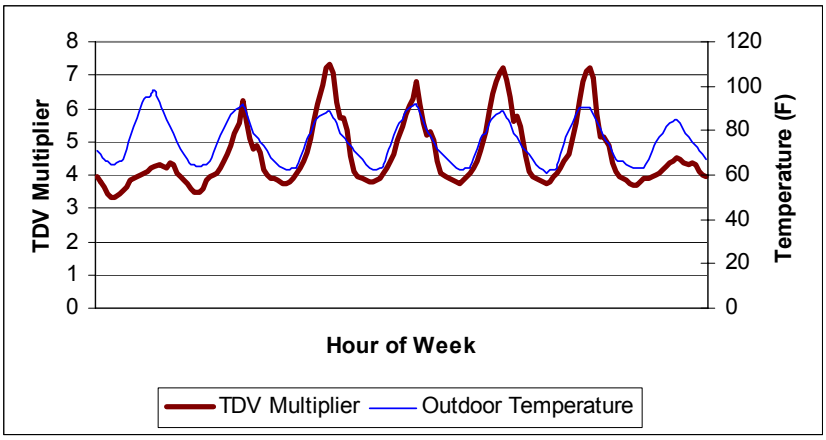


*Table 1-1. TDV Value Summary*

| Climate Zone | Electric Average | Electric Minimum | Month | Day | Hour | Electric Maximum | Month | Day | Hour |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.69 | 1.98 | June | 2 | 7 | 15.39 | August | 27 | 16 |
| 2 | 3.70 | 1.98 | June | 2 | 7 | 16.06 | August | 20 | 15 |
| 3 | 3.72 | 2.00 | June | 2 | 7 | 18.05 | September | 27 | 14 |
| 4 | 3.71 | 1.99 | June | 2 | 7 | 24.65 | August | 27 | 17 |
| 5 | 3.72 | 2.00 | June | 2 | 7 | 20.68 | September | 4 | 13 |
| 6 | 4.09 | 1.82 | June | 2 | 7 | 15.22 | September | 24 | 16 |
| 7 | 4.12 | 2.23 | June | 2 | 7 | 14.80 | August | 27 | 15 |
| 8 | 4.07 | 1.80 | June | 2 | 7 | 18.55 | August | 6 | 15 |
| 9 | 4.05 | 1.78 | June | 2 | 7 | 22.17 | September | 24 | 15 |
| 10 | 4.04 | 1.77 | June | 2 | 7 | 18.42 | August | 13 | 16 |
| 11 | 3.69 | 1.97 | June | 2 | 7 | 14.67 | August | 21 | 16 |
| 12 | 3.69 | 1.98 | June | 2 | 7 | 19.14 | August | 20 | 16 |
| 13 | 3.69 | 1.97 | June | 2 | 7 | 14.09 | August | 14 | 16 |
| 14 | 4.04 | 1.77 | June | 2 | 7 | 16.51 | August | 7 | 16 |
| 15 | 4.03 | 1.77 | June | 2 | 7 | 16.81 | August | 6 | 16 |
| 16 | 3.69 | 1.98 | June | 2 | 7 | 16.24 | August | 6 | 16 |
| ave | 3.86 | 1.92 | | | | 17.59 | | | |
| min | 3.69 | 1.77 | | | | 14.09 | | | |
| max | 4.12 | 2.23 | | | | 24.65 | | | |

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**Plan Checking MICROPAS Compliance Submittals**

The energy compliance plan check should include detailed review of the CF-1R Report. This chapter is the primary reference on the proper way to determine input values for analyzing buildings using MICROPAS. Except for some conversions by MICROPAS, the data listed on the CF-1R Report is the same data entered by the user. Chapter 4, Report Descriptions, discusses the compliance reports.

**HVAC Sizing**

Several values in the input data are used only for the HVAC Sizing calculations and do not affect the compliance result except when taking credit for verified maximum cooling capacity or electric based heating equipment like heatpumps are specified.

# Building Data

## Run Features

*Figure 2-3. Run Features Input Data*

```
RUN FEATURES
————————————
RUN
 1> RUN TITLE (25 char) ............................. Control Vent Crawlspace
 2> PROJECT TITLE (25 char) ......................... Example Run
 3> DOCUMENTATION AUTHOR (25 char) .................. Sample Author
BUILDING
 4> TYPE (Single, SingleAttached, MultiFamily) ...... Single
 5> CONSTRUCTION (New, Existing+Add+Alter, etc) ..... Existing+Add+Alter
 6> FRONT ORIENTATION (Compass deg or Cardinal) ..... 0
 7> NUMBER OF STORIES (1 or more) ................... 1
 8> FUEL TYPE (NaturalGas, Propane) ................. NaturalGas
 9> COMPLIANCE RUN (Compliance, Research, C-HERS) ... Compliance
 14> VINTAGE ASSUMPTIONS FOR EXISTING BUILDING ...... 1992-1998
```

**Input Data** | **Description: Run Features**

### RUN

*RUN TITLE* — Title of MICROPAS run. Maximum length is 25 characters.

*PROJECT TITLE* — Title of building project under analysis. This title appears on each page of the compliance reports. Maximum length is 25 characters.

*DOCUMENTATION AUTHOR* — Name of person performing the analysis. This name appears in the compliance reports. Maximum length is 25 characters.

### BUILDING

*BUILDING TYPE* — Type of building. This value is used to determine the magnitude of the water heating energy use for the Standard Design and for informational purposes in the compliance reports. Legal values are:

| | |
|---|---|
| 'Single' | Single family detached dwellings. |

| Input Data | Description: Run Features (cont.) |
|---|---|

| | | |
|---|---|---|
| | 'SingleAttached' | Single family attached dwellings (those with common walls but no common floors and ceilings). |
| | 'MultiFamily' | Multi-family dwellings such as apartments (those with common walls, floors and ceilings). |

*CONSTRUCTION* Used to set the type of building being modeled. This keyword tells MICROPAS how to label building surfaces on compliance reports. Legal values are:

| | |
|---|---|
| 'AdditionAlone' | Use this keyword when modeling an addition alone. This will place the word "New" on the CF-1R above opaque, glazing and mass surfaces. |
| 'Existing+Add+Alter' | This is a required keyword when performing existing plus addition and/or alteration calculations. When this keyword is selected, MICROPAS will require the user to identify existing, altered, deleted and new surfaces in the input file. See Advanced Topics, Chapter 3. |
| 'New' | This keyword is used for new construction that is not an addition or alteration. |
| Whole House | This keyword is used for an addition or alteration that will show compliance with current standards for the entire building. See Section 152(c) |

*FRONT ORIENTATION* ***Single Orientations:*** Compass orientation of the building front. The building front is considered the side of the building with the primary entry door. Units for this input are degrees using the following convention: 0 degrees = north, 90 = east, 180 = south, 270 = west, 30 = 30 degrees east of north, 225 = south west. See Figure 2-18 for an example of the input value FRONT ORIENTATION and PLAN AZIMUTH for the building surfaces.

☞ ***NOTE - Actual Orientation:*** *Enter the* ***actual*** *compass orientation, not just 0, 90, 180 or 270. For example, if the front on the building faces 17 degrees south of east, enter 90+17 or 107 degrees.*

***Multiple Orientations:*** For production housing, the user can run the four cardinal orientations by entering the keyword 'Cardinal' here. This will result in compliance calculations for the building facing north, east, south and west. The results of these four runs are summarized on a single report in order to minimize documentation and maximize clarity.

☞ ***NOTE - Cardinal Orientations:*** *When you run the calculations using 'Cardinal', MICROPAS requires you to use a Database of Run Results to store the four results. See Chapter 2 of the MICROPAS User's Manual for details of the MICROPAS data base features. Also see discussion on Production Housing in Chapter 3, Advanced Topics.*

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| Input Data | Description: Run Features (cont.) |
|---|---|

*NUMBER OF STORIES* Number of habitable stories of the building. This value affects the assumed wind speed used for natural ventilation calculations (see the NATURAL VENTILATION Section for more information). Legal values: integer, 1 to 3.

☞ ***NOTE – Number of Stories:*** *For single-family buildings, MICROPAS is not limited to 3 stories. MICROPAS restricts this input value to avoid confusion as to which multi-family projects can use MICROPAS for compliance. Once any building exceeds 1 story, whether it has 2 or more stories will not affect compliance results.*

*FUEL TYPE* Used to identify if natural gas is available for purposes of establishing the Standard Design. If natural gas is not available, set to Propane. Legal values: 'NaturalGas' or 'Propane'.

*COMPLIANCE RUN* The Compliance analysis type determines the level of input data available for analyzing the building. Enter 'Compliance' whenever preparing California compliance analyses. To perform research analyses (for those users with the research version), enter 'Research'. Legal values: 'Compliance', 'Research', 'C-HERS', and 'ComplianceSEER10'.

☞ ***NOTE –*** *Prior to January 23, 2006, compliance can be run with 10 SEER, which will assume 10 SEER in the standard design calculation on air conditioning equipment and either 6.6 HSPF for packaged heatpumps or 6.8 HSPF for split system heatpumps. On that date, the Federal minimum appliance efficiency standard for cooling equipment changes to a 13 SEER. For compliance calculations that will be submitted prior to January 23, 2006, you may use ComplianceSEER10.*

*VINTAGE ASSUMPTIONS FOR EXISTING BUILDING* The year that a building complying under Existing+Addition+Alteration was constructed. This value is used to determine which values in the table of defaults (Table 3-2) apply to the existing construction. If the building has a previously constructed addition, the vintage is the year the addition was permitted. Legal values: Before 1978, 1978-1983, 1984-1991, 1992-1998, 1999-2000, 2001-2003, 2004-2005, After 2005.

## RESEARCH

In research mode, the user is allowed to change assumptions that are normally fixed in compliance mode. Also, all reports will include a line which indicates MICROPAS was in research mode as follows:

```
*** Research Version, Not to be used for compliance ***
```

# Site and Weather Data

*Figure 2-4. Site and Weather Input Data*

```
SITE AND WEATHER DATA

 1> WEATHER DATA TYPE (FullYear, ReducedYear) ....... FullYear
 2> CEC CLIMATE ZONE (1 thru 16)..................... 12
```

**Input Data** **Description: Site and Weather Data**

The Site and Weather Data Section specifies the climate zone and the type of weather data to use in the analysis.

*WEATHER DATA TYPE* Type of weather data to use in the compliance analysis. MICROPAS must be run using full-year weather data (365 days)

*CEC CLIMATE ZONE* California climate zone number. A statewide listing of cities and their corresponding climate zones is provided in the *Building Energy Efficiency Standards,* Joint Appendix II. Legal values: integer between 01 and 16.

# HVAC Sizing

*Figure 2-5. HVAC Sizing Input Data*

```
HVAC SIZING
-----------

 1> SIZING LOCATION (25 char) ...................... MODESTO
```

**Overview** This section of input data applies only to the HVAC Sizing calculations. *It does not affect the compliance analysis except for buildings with heatpumps or electric heating and if the verified maximum cooling capacity credit is specified.* Some input data in the ZONE Section and the HVAC Systems Section also apply only to HVAC Sizing. See those sections for details.

MICROPAS calculates residential design heating and cooling loads based on the *ASHRAE Cooling and Heating Load Calculation Manual*. These loads are one of the factors used in selecting the HVAC (heating, ventilation and air conditioning) equipment for the building.

To determine the design load, the HVAC sizing calculations use a combination of indoor design conditions, outdoor design conditions and the thermal characteristics of the building. The thermal characteristics include: insulation levels, window orientation and shading, duct location, internal gains and infiltration control.

Heating and cooling systems operate most efficiently at their rated capacity. Oversized equipment operates at a fraction of the rated capacity, and cycles on and off excessively, wasting energy and shortening the life of the equipment. Design loads are calculated for a building to ensure that its HVAC system is sized correctly. Many of the old "rules of thumb" can lead to significantly oversized HVAC equipment.

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**Interpretation Of The Results**

The design heating and cooling loads calculated by MICROPAS are just one of the factors used when selecting the HVAC equipment for the building. Other factors that must be considered include:

- Heating and cooling output of available equipment.
- Duct losses.
- Fan size requirements for adequate air delivery.
- Building dehumidification requirements.
- Outdoor design conditions.
- Coil sizing.

In the course of a typical MICROPAS analysis the user must specify a minimum HVAC equipment efficiency. The sizing calculations will give the calculated design loads. In some cases, such as where very high efficiency equipment is used in MICROPAS calculations, it is advisable to search the sources of certified equipment to determine the availability of potential equipment that meets both the sizing and efficiency criteria. However, only a mechanical engineer or the mechanical contractor who is installing the equipment can select the HVAC equipment. The documentation author can provide the sizing calculations and efficiency requirements to the HVAC contractor and let them select the actual equipment.

**Multiple Zone Buildings**

Regardless of how the building is modeled for compliance purposes, a building with more than one HVAC system (more than one conditioned building zone) should have HVAC sizing calculations performed on a zone-by-zone basis for proper design of the HVAC system.

**Multi-Family Buildings**

For compliance purposes, the entire multi-family building is generally modeled as a single building zone. For sizing, it is appropriate to determine the loads on a unit-by-unit basis. This can be done by zoning the building unit-by-unit or creating a different input file for each type of unit in the building.

☞ ***NOTE - HVAC Sizing in Multi-Family Buildings:*** *Different units with the same floor plan can have widely varying design loads depending on their orientation and their placement within the building. End units on the top floor usually have the highest loads, interior units on the middle floor usually have the lowest loads. Sizing multi-family buildings for the "worst case" can provide quick results, but may end up costing the builder more for equipment that is unnecessarily large for some of the units.*

## Requirements For HVAC Sizing

**When Is HVAC Sizing Needed?**

The Mandatory Measures in the Standards require the design heat loss rate and design heat gain rate be determined by an acceptable method (ASHRAE). MICROPAS performs approved load calculations with its HVAC Sizing. These sizing calculations may be supplied to the person responsible for equipment selection, such as the mechanical contractor or installer. That individual is required to provide Form CF-6R, an Installation Certificate, which must be posted at the building site or provided to the inspector prior to final inspection. The CF-6R is not required for permit submittal. This form is intended to insure that installed equipment meets the efficiency requirements of the compliance documentation. It may also serve to demonstrate compliance with the UBC requirement that the heating system be capable of maintaining 70 degrees at a height three above the floor throughout the conditioned space of the building. See the *Residential Manual,* Chapter 4 for more information.

**Fixed Input Values**

The CEC requires that the calculations be based on an ASHRAE methodology (as used with MICROPAS) and that many of the input parameters be set to specific values. For example, the CEC specifies that indoor design temperatures be 70 degrees F in winter and 75 degrees F in summer.

**Maximum Equipment Size**

The CEC does not set a limit on the maximum gas furnace size or cooling equipment capacity. However, there is a credit available for HERS verified maximum cooling capacity. See COOLING SYSTEMS for details.

## Sizing Location Data

The sizing calculations use outdoor design temperatures found in the *Sizing Location Data* file. The location is specified by the input value SIZING LOCATION found in the HVAC Sizing Section of input. The location selected should be as close to the building site as possible. The sizing location should not be the representative city for the climate zone used in the compliance analysis unless that city is the closest location.

The Sizing Location Data file provided with MICROPAS contains data for most of the cities listed in *Building Energy Efficiency Standards*, Joint Appendix II (over 700 California cities). If an appropriate city for the building is not available in the Sizing Location Data file, a new location can be added (see the discussion on Editing Sizing Location Data in Appendix C).

**Where to Get Additional Sizing Location Data**

See *Building Energy Efficiency Standards*, Joint Appendix II.

| Input Data | Description: HVAC Sizing |
|---|---|
| *SIZING LOCATION* | Name of the HVAC Sizing location that is closest to the building site. The HVAC Sizing Location Data file contains the cooling and heating design temperatures for all the California locations found in the *Residential Manual*. Data for additional locations can be added as desired. A listing of these locations is found in the Appendix C. Maximum length is 25 characters. |
| ☞ | ***NOTE - Keyboard Shortcut:*** *The whole location name need not be entered. Instead, begin by entering the name. When MICROPAS determines the fewest characters that uniquely define a location, it will complete the entry. For example: 'G' will specify GARDEN GROVE, 'PISM' will specify PISMO BEACH and 'RIV' will specify 'RIVERSIDE'. You may also press the <F3> key to display a list of cities (by pressing the first letter of the city before pressing <F3>, the list begins with that letter so you do not have to scroll through the entire alphabet).* |

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# Calculations and Reports

*Figure 2-6. Calculations and Reports Input Data*

```
CALCULATIONS AND REPORTS
————————————————————————

CALCULATIONS
 1> COMPUTER PERFORMANCE TYPE (Both,Stand,Prop) ..... Both
 2> COMPUTER PERFORMANCE CALCULATION (Yes, No) ...... Yes
 3> WATER HEATING CALCULATION (Yes, No) ............. Yes
 4> HVAC SIZING CALCULATION (Yes, No) ............... Yes
COMPLIANCE REPORTS
 5> PRINT CF-1R REPORT (Yes, No) .................... Yes
 6> PRINT MF-1R REPORT (Yes, No) .................... Yes
 9> PRINT HVAC SIZING REPORT (Yes, No, Detailed) .... No
OTHER
 10> PRINT INPUT DATA (Yes, No, Unformatted) ........ No
 11> PRINT TABLE REPORTS (Yes, No, Delimited) ....... No
 12> STANDARD DESIGN INPUT DATA (Save, NoSave) ...... NoSave
```

The Calculations and Reports Section allows the user to vary the type of reports generated and the type of calculations performed. See What To Submit, found in Chapter 4, for a description of what documentation is required for an energy compliance submittal.

**Example** The data shown in Figure 2-6, is typical of what is required to produce the calculations and the compliance reports for an analysis with the Computer Performance compliance method as well as HVAC Sizing calculations.

**What to Submit for Compliance** Chapter 4, Report Descriptions, discusses the various compliance reports required and what to submit for performance compliance.

**Input Data** **Description: Calculations and Reports**

## CALCULATIONS

*COMPUTER PERFORMANCE TYPE* Keyword that specifies the type of Computer Performance compliance calculations for MICROPAS to perform. 'Both' requests the normal compliance calculation of both the Proposed Design energy use and the Standard Design energy use (also known as the energy budget). 'StandardOnly' requests only the Standard Design energy use calculations. 'ProposedOnly' requests only the Proposed Design energy use calculations.

*COMPUTER PERFORMANCE CALCULATIONS* Specifies whether space conditioning (excluding water heating energy budget) calculations are to be performed within the MICROPAS Computer Performance Calculations. To analyze water heating performance alone, save time by not running space conditioning calculations. Legal values: 'Yes' or 'No'.

*WATER HEATING CALCULATIONS* Specifies whether water heating calculations are to be performed. For normal compliance, this value should be 'Yes'. Legal values: 'Yes' or 'No'.

*HVAC SIZING CALCULATIONS* Specifies whether to perform HVAC Sizing calculations or not. Legal values: 'Yes' or 'No'.

☞ ***NOTE - HVAC Sizing Runs:*** *HVAC Sizing calculations can be performed without running the main MICROPAS calculations by using the HVAC Sizing option from the OTHER Operations Menu (accessed from the MAIN MENU).*

## COMPLIANCE REPORTS

*PRINT CF-1R REPORT* Specifies whether to print the CF-1R compliance report (also known as the *Certificate of Compliance*). A CF-1R must be included in the compliance submittal and be attached to the building plans. The CF-1R may be printed by MICROPAS or filled out by hand (see the *Residential Manual*). Legal values: 'Yes' or 'No'.

*PRINT MF-1R REPORT* Specifies whether to print the MF-1R compliance report (also known as the *Mandatory Measures Checklist*). An MF-1R must be included in the compliance submittal. The MF-1R may be printed by MICROPAS or filled out by hand (see the *Residential Manual*). Legal values: 'Yes' or 'No'.

*PRINT HVAC SIZING REPORT* Specifies whether to print the HVAC Sizing calculations report. A summary of the sizing calculation is also included on the CF-1R, so this report is optional. The input value HVAC SIZING CALCULATIONS must also be set to 'Yes' in order to print this report. For multi-zone buildings, a summary is printed by zone. The detailed report is not required and is not recommended for compliance purposes due to its length and complexity. Legal values: 'Yes', 'No' 'Detailed'.

☞ ***NOTE - Sizing Calculations:*** *Sizing calculations are required by the standards as part of the mandatory features. The sizing summary produced by MICROPAS may be provided to the person responsible for equipment selection, such as the mechanical contractor or installer, who completes a CF-6R form. The CF-6R form is an Installation Certificate and must be posted at the building site (or made available to the building inspector) and signed by the equipment installer prior to the final inspection. See Chapter 4 of the Residential Manual for more information on the CF-6R form.*

## OTHER

*PRINT INPUT DATA* Specifies whether to print the input data with the run and how to format the data. The input data is not required for a compliance submittal. It is, however, very useful for checking and archiving compliance analyses. Legal values: 'Yes', 'No' or 'Unformatted'.

☞ ***NOTE - Input Data Printout:*** *A printout of the input data can be obtained without running the main MICROPAS calculations by using the Print Copy of Input option found on the OTHER Operations Menu (available through the MAIN MENU).*

**Input Data** **Description: Calculations and Reports (cont.)**

*PRINT TABLE REPORTS* Specifies whether the requested Table Reports are printed. Table Reports are requested in the Table Reports Section of input. The Table Reports are useful to see the detailed results of the MICROPAS simulation but are never appropriate for compliance submittals. If the keyword 'Delimited' is selected, MICROPAS will output the file in a "comma delimited" format. This format allows the file to be read by spreadsheet programs and enables the output to be converted into a graph or chart. Legal values: 'Yes', 'No', 'Delimited'.

☞ ***NOTE - Table Reports:*** *The PRINT TABLE REPORTS value must be set to 'Yes' or 'Delimited' before MICROPAS will display the Table Reports Section of data for you to edit - the MISCELLANEOUS menu will appear under the MICROPAS EDIT MENU when 'Yes' or 'Delimited' is selected.*

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*STANDARD DESIGN INPUT DATA*

Specifies whether the input data for the Standard Design energy use is saved on disk. Note that the Standard Design building is created internally by MICROPAS. If saved, the file name extension is '.CBx' (x = current version number). The Standard Design input file can converted to a regular Micropas file (‘.MPx’) using the CONVERT INPUT FILES feature found under OTHER OPERATIONS. Since the Proposed Design is compared to the Standard Design, the printout of the Standard Design input file may be useful in figuring out how to bring difficult buildings into compliance. Legal values: 'Save' or 'NoSave'.

# Zone

*Figure 2-7. Zone Input Data*

```
 1> ZONE NAME ..................................... HOUSE
 2> CONDITIONED (Yes, No) ......................... Yes
 3> ZONE TYPE ..................................... Residence
 4> FLOOR AREA (sf) ............................... 1600
 5> VOLUME (cuft) ................................. 12800
 6> NUMBER OF DWELLING UNITS ...................... 1
CREDITS
 7> HOUSEWRAP/VERIFIED AIR LEAKAGE (Yes,No,SLA) ..... No
 8> RADIANT BARRIER (Yes, No, CoolRoof) ............. Yes
 9> VERIFIED INSULATION QUALITY (Yes, No) ........... No
HVAC SYSTEM
 10> NUMBER OF SYSTEMS SERVING ZONE ................ 1
 11> HEATING SYSTEM NAME ........................... FURN.80
 12> COOLING SYSTEM NAME ........................... AC.13.0.TXV
 13> DUCT SYSTEM NAME .............................. R6.0.TEST
 14> NATURAL VENTILATION SYSTEM NAME ............... ONE.STORY
 15> FAN VENTILATION SYSTEM NAME ................... None
 16> THERMOSTAT NAME ............................... Setback
HVAC SIZING
 17> NUMBER OF PEOPLE/UNIT (occupants/unit) ......... 4
```

**Overview**

Compliance analysis for most residential buildings will treat the entire building as a single zone. Multi-zone buildings include buildings with attached sunspaces, controlled ventilated crawlspaces, zonally controlled HVAC systems and multiple HVAC systems. The CEC has approved methods for modeling multi-zone building energy features, which are described in Chapter 3, Advanced Topics. The discussion in this chapter assumes a single zone building.

The ZONE Section specifies the size of the zone, the type of HVAC equipment that conditions the zone and other information related to the zone.

There are two options and procedures for obtaining compliance credit for reduced building envelope air leakage. These credits require installation of an approved housewrap product or HERS verified testing the air infiltration of the constructed house with a blower door.

**Indirectly Conditioned Spaces**

An indirectly conditioned space is one that does not receive direct space heating or cooling, but is thermally influenced more by the conditioned space than by outdoor conditions. Common examples of this are: enclosed entries, utility rooms and closets. The floor area of indirectly conditioned spaces must be included in the conditioned floor area total entered here in the ZONE Section. See definition of "Indirectly Conditioned Spaces" in the *Building Energy Efficiency Standards*, Joint Appendix I for details on how to determine if a space is indirectly conditioned.

**Unconditioned Spaces**

The thermal effects of unconditioned spaces adjoining conditioned space (such as a garage, crawlspace or sunspace) are typically modeled one of two ways:

1. By adjusting the solar gains, U-factor or slab edge (see OPAQUE SURFACES Section for more information).

2. By modeling the attached space as a separate zone (see Chapter 3, Advanced Topics, for more information).

**Housewrap**

A reduction (credit) of 0.50 Specific Leakage Area (SLA) is applied if an air retarding wrap (e.g., housewrap) is installed and diagnostic infiltration testing credit is **not** claimed.

To qualify for the housewrap compliance credit, the proposed housewrap must be tested and labeled by the manufacturer to comply with ASTM E1677-95, *Standard Specification for an Air Retarder (AR) Material or System for Low-Rise Framed Building* Walls, and have a minimum perm rating of 10. The housewrap must be installed per the manufacturer's specifications. See the *Residential Manual*, Chapters 3 for additional qualifying and installation information.

A HERS rater verification is not required.

☞ ***NOTE – Air Retarding Wrap:*** *Insulative sheathing and building paper do not qualify as air retarding wraps.*

☞ ***NOTE – Combined Housewrap and Duct Credits:*** *The credits for a housewrap and the envelope leakage credit for reduced duct leakage are combined when* ***both*** *measures are installed. All of the same installation and qualifying criteria apply. This combination of credits is indicated when the input for "Housewrap/Air Infiltration Credit" is set to "Yes" and the DUCT SYSTEMS input for "Tested Leakage" is also set to "Yes".*

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*Table 2-16. System Component Descriptions: Distribution Systems*

| Distribution Systems | Description |
|---|---|
| Standard | Standard system without any pumps for distributing hot water. The first 5 feet of pipes from the storage tank is insulated for both hot and cold water pipes. Pipes from the water heater to the kitchen that are 3/4" or larger are insulated. Pipe insulation is required per §150(j). |
| Standard Pipes with No Kitchen Pipe Insulation | Standard system, but without insulation on the pipes to the kitchen. |
| Point of Use | System with no more than 8' horizontal distance between the water heater and hot water fixtures, except laundry. (Not used with central systems in multi-family buildings.) |
| Parallel Piping | Systems with individual pipes from the water heater to each fixture. |
| Pipe Insulation | R-4 (or greater) insulation applied to 3/4" or larger, non-recirculating hot water mains (or pipes buried under attic insulation) in addition to insulation required by the Standards, Section 150(j) (first five feet from water heater on both hot and cold water pipes). |
| Recirculation: No Control | Distribution system using a pump to recirculate hot water to branch piping through a looped hot water main with no control of the pump, such that water flow is continuous. (Not used with instantaneous water heaters.) Pipe insulation is required. |
| Recirculation: Temperature | Recirculation system that uses temperature controls to cycle pump operation to maintain recirculated water temperatures within certain limits. (Not used with instantaneous water heaters.) Pipe insulation is required. |
| Recirculation: Time | Recirculation system that uses a timer control to cycle pump operation based on time of day. (Not used with instantaneous water heaters.) Pipe insulation is required. |
| Recirculation: Time/Temp | Recirculation system that uses both temperature and timer controls to regulate pump operation. (Not used with instantaneous water heaters.) Pipe insulation is required. |
| Recirculation: Demand | Recirculation system that uses brief pump operation to recirculate hot water to fixtures just prior to hot water use when a demand hot water is indicated. (Not used with instantaneous water heaters or with central systems in multi-family buildings.) |

**Standard Design Water Heating Energy Use**

The Standard Design water heating energy use varies by dwelling unit size and for multi-family buildings by water heating type. For single and multi-family dwelling units, MICROPAS will read the building square footage and the number of dwelling units from the ZONE Section. When multi-family water heating is provided by a central system, the standard design will also be a central system.

**Multiple Water Heaters**

More than one water heater may be installed in a single building. This occurs frequently in large single family homes and in multi-family dwellings. Figure 2-46 below shows the inputs for a single building with two gas water heaters of the same make and model, and with one single instantaneous water heater.

*Figure 2-46. Multiple Water Heaters Example Input Data*

```
WATER HEATING SYSTEMS
─────────────────────

 #> NUMBER OF WATER HEATING SYSTEMS (25 maximum) .... 2
      WATER          WATER                          # OF             HYDRONIC/
      HEATING        HEATING        HEATER/BOILER HEATERS/BOILERS RECIRC
      NAME           TYPE           SYSTEM NAME   INSTALLED       SYSTEM NAME
      ──────1─────── ──────2─────── ──────3─────── ────────4──────── ──────5───────
 1>   GAS.40GAL      DHW            GAS.STOR.40   2               None
 2>   INSTANT.HW     DHW            GAS.INST      1               None

HEATER/BOILER SYSTEM 'GAS.STOR.40'
──────────────────────────────────

 1> HEATER/BOILER SYSTEM NAME ..................... GAS.STOR.40
 2> TANK TYPE (Storage, Instantaneous, etc.) ..... Storage
 3> HEATER ELEMENT TYPE (Electric, Gas, HeatPump) ... Gas
 4> DISTRIBUTION TYPE (Standard, PointOfUse, etc.) .. Standard
 5> ENERGY FACTOR ................................. 0.58
 6> TANK VOLUME (gallons) ......................... 40
 7> RATED INPUT (Btuh) ............................ 35000
 12> RECOVERY EFFICIENCY (fraction) ............... n/a
 13> STANDBY LOSS (fraction) ...................... n/a
WATER HEATING CREDIT
 14> CREDIT TYPE (None, Solar, WoodStove) ......... None

HEATER/BOILER SYSTEM 'GAS.INST'
───────────────────────────────

 1> HEATER/BOILER SYSTEM NAME ..................... GAS.INST
 2> TANK TYPE (Storage, Instantaneous, etc.) ..... Instantaneous
 3> HEATER ELEMENT TYPE (Electric, Gas, HeatPump) ... Gas
 4> DISTRIBUTION TYPE (Standard, PointOfUse, etc.) .. Standard
 5> ENERGY FACTOR ................................. n/a
 7> RATED INPUT (Btuh) ............................ n/a
 9> PILOT LIGHT SIZE (Btuh) ....................... 500
 11> INTERNAL INSULATION R-VALUE (hr-sqft-F/Btu) .... n/a
 12> RECOVERY EFFICIENCY (fraction) ............... 0.76
 13> STANDBY LOSS (fraction) ...................... n/a
WATER HEATING CREDIT
 14> CREDIT TYPE (None, Solar, WoodStove) ......... None
```

**Multi-Family Dwellings**

The water heating budget for individual dwelling units depends on the size of the unit. For single-family dwellings, the unit size is taken from the information in the ZONE Section.

For multi-family dwelling units, MICROPAS will create an individual water heating budget based on the *average* size of the dwelling units. MICROPAS will determine the average unit size from information entered in the ZONE Section. Many multi-family water heating system combinations may be modeled with MICROPAS. These include:

- Central systems
- Individual systems
- Central plus individual systems (with limitations)

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***Multi-Family Central Systems:*** When modeling a central water heating system, you must select the keyword 'DHWCentral' under water heating type. MICROPAS will then check the number of dwelling units entered under the ZONE Section. If the number of dwelling units is greater than 1, it is assumed that the water heating system serves the entire building. Note that the central water heating system may consist of more than one water heaters and may require the specification of recirculation piping between buildings in a multi-family complex. Figure 2-47 below demonstrates such a system:

*Figure 2-47. Multi-Family Central Water Heating System*

```
ZONE 'HOUSE'
____________

6> NUMBER OF DWELLING UNITS ....................... 10

WATER HEATING SYSTEMS
_____________________

 #> NUMBER OF WATER HEATING SYSTEMS (25 maximum) .... 1
      WATER          WATER                    # OF             HYDRONIC/
      HEATING        HEATING       HEATER/BOILER HEATERS/BOILERS RECIRC
      NAME           TYPE          SYSTEM NAME   INSTALLED       SYSTEM NAME
      ______1_______ _______2_____ _______3_____ ________4_____ _______5_____
 1>   GAS.CENTRAL    DHWCentral     GAS.LARGE.75 2               PIPING
```

***Multi-Family With Individual Water Heaters:*** When modeling a multi-family building with individual water heaters, MICROPAS will check to make sure that the number of individual water heaters matches the number of dwelling units entered in the ZONE Section. The total number of non-central water heating systems must be equal to or a direct multiple of the number of dwelling units. Figure 2-48 illustrates this situation. Note that a direct multiple number of systems example would be 10 dwelling units with 10 storage gas heaters and 10 instantaneous heaters.

☞ ***NOTE - Multi-family Water Heaters -*** *For multi-family buildings, the number of non-central water heating systems must be equal to or a direct multiple of the number of dwelling units.*

*Figure 2-48. Multi-Family with Individual Water Heaters*

```
ZONE 'HOUSE'
____________

 6> NUMBER OF DWELLING UNITS ....................... 10

WATER HEATING SYSTEMS
_____________________

 #> NUMBER OF WATER HEATING SYSTEMS (25 maximum) .... 2
      WATER          WATER                    # OF             HYDRONIC/
      HEATING        HEATING       HEATER/BOILER HEATERS/BOILERS RECIRC
      NAME           TYPE          SYSTEM NAME   INSTALLED       SYSTEM NAME
      ______1_______ _______2_____ _______3_____ ________4_____ _______5_____
 1>   40GALLON       DHW           GAS.STOR.40   7               None
 2>   50GALLON       DHW           GAS.STOR.50   3               None
```

***Multi-Family With Combination Central and Non-Central Systems:*** This situation combines the rules from both examples above. Any number of central systems are allowed (provided they are identical systems), however, the number of non-central water heaters must be equal to (or be a direct multiple of) the number of dwelling units. Figure 2-49 illustrates such a system:

*Figure 2-49. Multi-Family with Mixed Central & Individual Water Heating Systems*

```
ZONE 'HOUSE'
 6> NUMBER OF DWELLING UNITS ..................... 10

WATER HEATING SYSTEMS
 #> NUMBER OF WATER HEATING SYSTEMS (25 maximum) .... 3
      WATER          WATER                    # OF             HYDRONIC/
      HEATING        HEATING       HEATER/BOILER HEATERS/BOILERS RECIRC
      NAME           TYPE          SYSTEM NAME   INSTALLED       SYSTEM NAME
      ------1------ ------2------ ------3------ -------4------- ------5------
 1>   CENTRAL.SYST   DHWCentral    GAS.LARGE.75  2               None
 2>   40GALLON       DHW           GAS.STOR.40   7               None
 3>   50GALLON       DHW           GAS.STOR.50   3               None
```

☞ ***NOTE - Complex Multi-family Water Heating Systems:*** *Due to constraints in the water heating methodology, some extremely rare water heating situations may require multiple MICROPAS runs. If you have problems modeling a complex system, call Enercomp.*

**Combined Hydronic/ Hydronic Systems**

Combined hydronic/hydronic space and/or water heating systems are modeled through both the HVAC System Section and the WATER HEATING Section. This chapter includes a separate section that explains how to model combined hydronic/hydronic systems (see Hydronic Space Heating Systems later in this section).

**Solar Water Heating/Woodstove Boiler Credits**

A method for attaining credit for active or passive solar systems, or a woodstove boiler system is available through MICROPAS. See the "Solar or Woodstove Boiler Credits" section under the HEATER/BOILER SYSTEMS Section in this chapter for details.

# Water Heating Systems

*Figure 2-50. Water Heating Input Data*

```
WATER HEATING SYSTEMS
 #> NUMBER OF WATER HEATING SYSTEMS (25 maximum) .... 1
      WATER          WATER                    # OF             HYDRONIC/
      HEATING        HEATING       HEATER/BOILER HEATERS/BOILERS RECIRC
      NAME           TYPE          SYSTEM NAME   INSTALLED       SYSTEM NAME
      ------1------ ------2------ ------3------ -------4------- ------5------
 1>   CONVENTIONAL   Standard      None          1               None
```

Within this section of data you list one or more types of water heaters that are to be installed in the building. The heaters/boilers and the hydronic systems listed here must also be defined in the HEATER/BOILER SYSTEMS and HYDRONIC SPACE HEATING SYSTEMS Sections.

For clarity, a water heating system is comprised of one or more identical water heaters. If a building has more than one type of water heater, then each type must be treated as a system. For example, see Figure 2-49 where there are 12 water heaters and 3 systems.

☞ ***NOTE - Water Heating System Values:*** *The values listed in the figures that appear in this section are merely examples and should* ***not*** *be used for compliance. Use actual values for actual water heaters.*

**Hydronic Space Heating**

A description of how to model hydronic space heating systems is found in the HYDRONIC SPACE HEATING SYSTEMS Section that appears later in this chapter.

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**Water Heater Input Data**

The inputs required for the Water Heater Section of input vary according to the type of heater being analyzed. Table 2-17 lists the heater specifications that are required for each type of water heater. Note that the inputs for this section may vary depending on the combination of TANK TYPE and HEATER ELEMENT. All available inputs are listed in Table 2-18.

*Table 2-17. Required Water Heater Specifications by Type*

| | Storage Gas | Lg. Storage Gas | Storage Electric | Storage Heat Pump | Instant Gas | Instant Gas | Indirect[1] Electric |
|---|---|---|---|---|---|---|---|
| *TANK TYPE:* | Storage | Lg Storage | Storage | Storage | Instant. | Instant. | Indirect |
| *HEATER ELEMENT:* | Gas | Gas | Electric | Heat Pump | Gas | Electric | Gas |
| *DISTRIBUTION TYPE:* | YES | YES | YES | YES | YES | YES | YES |
| *ENERGY FACTOR:* | YES | n/a | YES | YES | n/a | n/a | n/a |
| *TANK VOLUME:* | YES | YES | YES | YES | n/a | n/a | YES |
| *RATED INPUT (Btu/h):*[2] | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| *RATED INPUT (kWh):*[2] | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| *PILOT LIGHT:* | n/a | n/a | n/a | n/a | YES | n/a | YES |
| *EXTERNAL INSULATION:* | n/a | YES | n/a | n/a | n/a | n/a | YES |
| *INTERNAL INSULATION:* | n/a | n/a | n/a | n/a | n/a | n/a | YES |
| *RECOVERY EFF/AFUE:* | n/a | YES | n/a | n/a | YES | YES | YES[1] |
| *STANDBY LOSS:* | n/a | YES | n/a | n/a | n/a | n/a | n/a |
| *CREDIT TYPE:* | if appl | if appl | if appl | if appl | if appl | if appl | if appl |
| *PUMP USED:* | if appl | if appl | if appl | if appl | if appl | if appl | if appl |
| *SOLAR FRACTION:* | if appl | if appl | if appl | if appl | if appl | if appl | if appl |

1. If the indirect gas water heating system is instantaneous, use the water heater Recovery Efficiency.
2. Btu/hr and kWh input ratings are only input for hydronic heating systems.

*Table 2-18. Water Heater Input Summary*

| Input Item | Storage Gas | Storage Electric | Heat Pump | Instant Gas | Instant Electric | Lg Storage Gas | Indirect Gas |
|---|---|---|---|---|---|---|---|
| Energy Factor | Yes | Yes | Yes | Yes | Yes | | |
| Pilot Input, Btu | | | | Yes | | Yes | Yes |
| Efficiency, % | | | | Yes | Yes | Yes[1] | Yes |
| Standby Loss, % | | | | | | Yes | |
| Tank Volume, gal | Yes | Yes | Yes | | | Yes | Yes |
| Tank Insulation, R | | | | | | | Yes |
| Ext. Insulation, R | | | | | | Yes | Yes |
| If Combined Hydronic System: | | | | | | | |
| Rated Input, kBtuh | Yes | | | | | Yes | Yes |
| Rated Input, kWh | | Yes | Yes | | | | |
| Recovery Eff, % | Yes | | Yes | | | Yes | Yes |
| Pump Input, Watts | | Yes | | | | | |

1. May be recovery efficiency, thermal efficiency, or AFUE.

| Input Data | Description: Heater/Boiler System |
|---|---|

☞ ***NOTE - Multiple Water Heaters:*** *All values entered here are "per heater." MICROPAS makes appropriate adjustments when multiple water heaters are specified in the WATER HEATING SYSTEMS Section.*

*HEATER/BOILER SYSTEM NAME* Name of the heater/boiler system. This name is entered in the WATER HEATING SYSTEMS Section to include one or more heater(s), other than Standard, in the building. Maximum length is 12 characters.

*TANK TYPE* Type of water heater tank. Legal values are:

| | |
|---|---|
| 'Storage' | This keyword is used for modeling water heaters with water storage capacity greater than two gallons and an input rating of 75,000 Btu/h or less. |
| 'Instantaneous' or 'Tankless' | Use this keyword for instantaneous, "demand," or "tankless" water heaters that have a storage capacity of less than two gallons. Boilers are often found in this category. |
| 'Large' | Used for storage type water heaters with an input rating greater than 75,000 Btu/hr. |
| 'Indirect' | This keyword is for systems that consist of an insulated tank with no internal heating system. Indirect systems are connected via piping and a pump to an instantaneous water heater or boiler. |

*HEATER ELEMENT TYPE* Type of heating element. Legal values are:

| | |
|---|---|
| 'Gas' | Used for gas or oil fired heaters. |
| 'Electric' | Used for electric resistance heaters. |
| 'HeatPump' | Used for heat pump water heaters. |

*DISTRIBUTION TYPE* Describes the water heating distribution system. For a complete description of distribution systems, see Table 2-16, System Component Descriptions: Distribution Systems. Note that, other than pre-defined combinations, only one distribution credit/penalty system is allowed per water heating system. If you are modeling multiple water heating systems, each independent system may have its own distribution system. The descriptions below indicate whether the distribution system yields a water heating credit or penalty. Legal Values are:

| | |
|---|---|
| 'ParallelPiping' | *Credit:* Use for systems where each hot water draw point is served by a separate pipe from the water heater. |
| 'PipeInsulation' | *Credit:* Used when R-4 (or greater) insulation is applied to 3/4" or larger, non-recirculating hot water mains. This requirement is in addition to the mandatory pipe insulation (first 5ft from the water heater on both hot and cold water pipes). |

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| Input Data | Description: Heater/Boiler System (cont.) |
|---|---|

| | |
|---|---|
| 'Point of Use' | *Credit:* Use this keyword for systems that have no more than 8' horizontal distance between the water heater and hot water fixtures (laundry facilities may be located more than 8 feet from the water heater). |
| 'Recirc/Demand' | *Credit (very small):* Used for a recirculation system that uses brief pump operation to recirculate hot water to fixtures just prior to hot water use. |
| 'Recirc/NoControl' | *Penalty:* Used for systems that use a pump to recirculate hot water to branch piping through a looped hot water main with no control of the pump, such that water flow is continuous. |
| 'Recirc/Temp' | *Penalty (small):* Used for a recirculation system that uses temperature controls to cycle pump operation to maintain recirculated water temperatures within certain limits. |
| 'Recirc/TimeTemp' | *Credit (small):* Used for a recirculation system that uses both temperature and timer controls to regulate pump control. |
| 'Recirc/Timer' | *Penalty:* Used for a recirculation system that uses a timer control to cycle pump operation based on time of day. |
| 'Standard' | *No Credit or Penalty:* Used for standard water heating systems without any pumps for distributing hot water, and mandatory pipe insulation, including 3/4" hot water pipes from water heater to kitchen insulated with 1" of insulation. |
| 'StandardNoInsul' | *Penalty*: Used for standard pipe insulation with no insulation on kitchen water pipes. |
| 'N/A' | *No Credit or Penalty:* Use this value when describing the space heating side of a separate hydronic system. |

*ENERGY FACTOR* The energy factor (ratio of energy output to energy consumption) for a water heater. This value can be found in CEC approved water heater directories or the CEC appliance database. The CEC "standard" 50 gallon water heater has an approximate energy factor of 0.575. Typically the energy factor is less than one, except for heat-pump water heaters, which will typically have an energy factor rating greater than two. Note that the energy factor includes other system losses such as standby loss. Units: none.

*TANK VOLUME* Water heater tank volume for tank-type water heaters. This value is found in CEC approved water heater directories. Units: gallons.

*RATED INPUT (BTU/HR OR KW)* The heating input of the system. Note that this value is only necessary for combined hydronic or hydronic only heating systems. Units: Btu/hr or kW, depending on the heater element type.

| Input Data | Description: Heater/Boiler System (cont.) |
|---|---|

*PILOT LIGHT* The pilot light energy consumption for instantaneous/tankless, indirect gas or boiler water heating systems. Units: Btu/hr

*EXTERNAL INSULATION* Specification of the R-value of insulation that is physically wrapped around the tank. This value applies only to large gas storage-type water heating systems and indirect gas water heaters. Legal values: R-0 to (no maximum).

*INTERNAL INSULATION* Specification of the R-value of insulation that is internally installed by the manufacturer. This value is found in the certification information for water heaters and applies only to indirect gas water heaters. Legal Values: R-0 to (no maximum).

*RECOVERY EFFICIENCY/AFUE* Recovery (or thermal) efficiency of water heater. This input applies to large storage gas, indirect gas, instantaneous/tankless gas systems and to storage water heaters in a combined hydronic system. For indirect gas systems, use the AFUE rating for a boiler or the recovery efficiency of an instantaneous/tankless heater. Units: Btu output/Btu input (fraction).

☞ ***NOTE - Recovery Efficiency:*** *The recovery efficiency percentage listed in some directories must be divided by 100 before entering into MICROPAS (e.g., 78.0 / 100 = 0.78).*

*STANDBY LOSS* Rated standby loss of tank. This input only applies to large storage water heaters. For other storage water heaters, the standby loss is included in the Energy Factor. Units: standby load/water heating load (fraction).

☞ ***NOTE - Standby Loss:*** *The standby loss percentage listed in some directories must be divided by 100 before entering into MICROPAS (e.g., 3.5 / 100 = .035).*

## Solar or Woodstove Boiler Credit

**Overview** Credit for energy sources external to the water heating system is available through MICROPAS. These sources are:

- Active Solar Systems (includes mechanical pumps)
- Passive Solar Systems (does not include mechanically operated pumps)
- Woodstove Boilers

**Active Solar Systems** To allow credit for active solar systems, a CEC approved version of the FCHART program must be run to determine the system performance. Performance of the system is based on *net solar fraction* (NSF) which indicates the percentage of domestic water heating needs that are supplied by the solar system. This value is then entered into MICROPAS under the HEATER/BOILER SYSTEMS Section. See Chapter 5 of the *Residential Manual* for input restrictions for the FCHART program.

☞ ***NOTE - Solar System Credits:*** *Specific performance information for the solar system being evaluated must be obtained before proceeding with solar water heating calculations. See Chapter 5 of the Residential Manual for more information.*

**Passive Solar Systems** Passive solar systems do not use mechanical pumps to move heated water from the collection area to the storage area. Performance of the system is based on *net solar fraction,* which indicates the percentage of domestic water heating needs that are supplied by the solar system. The net solar fraction for passive solar systems must be **hand calculated** by using **Form CF-SR** before entering the result in MICROPAS. See Chapter 5 of the *Residential Manual* for details on how to fill out the worksheet.

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# Chapter 3: ADVANCED TOPICS


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# Overview

This chapter describes advanced compliance topics that may be useful after the user becomes familiar with the input values for the more common buildings as described in Chapter 2, Input Reference.

**Program Assumptions**

The CEC has fixed a number of modeling assumptions for the typical building analysis as well as for the special models described in this chapter. These modeling assumptions are discussed in Appendix E, Program Assumptions.

# Building Types

## Multi-family Housing

**Overview**

For discussion purposes, any building that has more than one dwelling unit (apartment, condominium, duplex, triplex, etc.) is considered a multi-family building. Multi-family buildings are specified by entering 'SingleAttached' (such as duplexes, which share common walls but no common floors/ceilings) or 'MultiFamily' for the input value BUILDING TYPE in the RUN FEATURES Section of input. For compliance analysis, it is the permit applicant's option to analyze the whole building or to analyze the building on a unit-by-unit basis. The whole building approach generally provides the best compliance result and requires the least analysis effort.

With either technique, ignore all building components that are between the conditioned space of the other dwelling units (i.e., common floors, walls and ceilings.)

**HVAC Sizing**

The calculations performed to determine the size of the HVAC equipment should always be based on a unit-by-unit analysis. One approach to this is to size the equipment based on the requirements of the "worst case" dwelling unit (usually an upper level unit with a large surface area exposed). This approach should be used with caution because it often leads to oversized equipment (and thus added construction costs) for the other units in the building. A preferable method is to size the HVAC equipment for a variety of unit types (upstairs versus downstairs units, end units versus interior units, etc.)

**Water Heating**

Several water heating systems for multi-family dwellings may be modeled using MICROPAS. These include:

- Central water heating systems with or without piping between buildings
- Individual or non-central systems
- Central plus non-central systems (with some restrictions)

See Chapter 2, Input Reference, for more information on how to model water heating systems.

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# Production Housing

Production housing is a single building plan built more than once within a subdivision. The permit applicant can choose one of three options to compliance for the production housing. These two options are listed in Table 3-1 and further described on the succeeding pages.

*Table 3-1. Production Housing Compliance Options*

| Production Housing Compliance Options | Number of Runs | Demonstration of Compliance |
|---|---|---|
| *Individual Orientations* | one run for each actual orientation | comply with each orientation individually |
| *Multiple Orientations* | four runs: one for each of the four cardinal orientations | all four orientations must comply using the same set of energy features |

## Individual Orientations

This method requires analyzing and achieving compliance for each orientation of the building individually. A set of compliance documentation is submitted for each orientation. When possible, lot numbers are supplied on the compliance reports to establish which set of compliance documentation applies to which buildings within the development.

## Multiple Orientations

MICROPAS has a special feature that automatically calculates the *Multiple Orientation* method of compliance. This feature minimizes effort and reduces the amount of compliance documentation.

This method requires that each building plan have a fixed set of energy related features (areas, insulation levels, etc.) that do not change as the building is built in different orientations. Compliance is achieved by showing that the building meets the standard energy budget in each of the four cardinal orientations with the same energy features.

MICROPAS automates this method by generating compliance calculations for each of the four cardinal orientations (north, east, south and west). To use this feature, set the input value FRONT ORIENTATION (in the Building: Run Features Section) to 'Cardinal'. MICROPAS calculates compliance for all four orientations.

MICROPAS produces a single CF-1R report which documents compliance for all four orientations. An example of the run results summary found on the CF-1R report is shown in Figure 3-1.

*Figure 3-1. Example Multiple Orientation Results Found on CF-1R Report*

MICROPAS7 ENERGY USE SUMMARY

| Energy Use (kTDV/sf-yr) | Standard Design | Proposed Design | Compliance Margin |
|---|---|---|---|
| Space Heating..... | 15.19 | 17.06 | -1.87 |
| Space Cooling..... | 11.97 | 10.11 | 1.86 |
| Water Heating..... | 13.53 | 12.91 | 0.62 |
| North Total | 40.69 | 40.08 | 0.61 |
| Space Heating..... | 15.19 | 17.46 | -2.27 |
| Space Cooling..... | 11.97 | 14.32 | -2.35 |
| Water Heating..... | 13.53 | 12.91 | 0.62 |
| East Total | 40.69 | 44.69 | -4.00 |
| Space Heating..... | 15.19 | 17.50 | -2.31 |
| Space Cooling..... | 11.97 | 10.50 | 1.47 |
| Water Heating..... | 13.53 | 12.91 | 0.62 |
| South Total | 40.69 | 40.91 | -0.22 |
| Space Heating..... | 15.19 | 17.42 | -2.23 |
| Space Cooling..... | 11.97 | 13.51 | -1.54 |
| Water Heating..... | 13.53 | 12.91 | 0.62 |
| West Total | 40.69 | 43.84 | -3.15 |

*** Building does not comply with Computer Performance ***
*** HERS Verification Required for Compliance ***

# Additions and Alterations

**Overview**

All building additions and many alterations must comply with the energy standards. Regardless of the size of an addition, MICROPAS may be used to demonstrate compliance. Energy compliance must also be shown in the case where the floor area is increased in one portion of the building and decreased in another.

Under the standards, additions are defined as modifications that increase the conditioned floor area and volume of the building. Alterations are defined as changes to a building's envelope, space-conditioning system, water-heating system or lighting system, that are not additions. An alteration does not increase both conditioned volume and floor area. See Chapter 8 of the Residential Manual for more information on additions and alterations.

For alterations, there may be some cases where compliance with a particular aspect of the prescriptive requirements is not desirable or feasible, in which case MICROPAS can be used to show compliance for the alteration.

There are three methods of analyzing building additions and alterations in MICROPAS:

1. Modeling the whole building
2. Modeling the addition or alteration alone.
3. Modeling the existing building with the addition and/or alteration (Existing + Addition + Alteration Method).

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☞ ***NOTE – For Users of Previous Versions:*** *Unlike previous versions where two files were necessary for the existing plus addition approach this version requires a single input file with information about the existing building and all changes. For accurate results, the user must specify the correct tags (/E for existing, /N for new (added), /D for deleted or /A for altered) in many sections of the input file. New editor commands using the Alt key have been added to make it easier to enter tags. Compliance documentation requires only a single CF-1R that documents the building both before and after construction.*

☞ ***NOTE – Wall Insulation:*** *Wall insulation for new structures must be at least R-13. However, if an existing insulated wall has R-11 insulation, the energy standards allow an exception to the R-13 mandatory requirement as long as the overall structure complies with the energy budget. Model any existing R-11 walls as R-11.*

☞ ***NOTE - Skylights, Greenhouse Windows:*** *If a* ***dual glazed*** *greenhouse window (which adds volume but not floor area to a building) or skylight is installed in an addition, it can be modeled with the following U-factor:*

| **Climate Zones** | **U-value** |
|---|---|
| 1, 2, 10, 11, 12, 13, 14, 15 | 0.57 |
| 3, 4, 5, 6, 7, 8, 9 | 0.67 |
| 16 | 0.55 |

## Whole Building Method

With this approach, model the entire building including the existing and added or altered portions as though it were a new house. This is sometimes useful in situations where the home is being completely rebuilt, such as after a fire or on tear downs, but requires that the entire home meet the current standard. The building must have a compliance margin of 0 or positive. The building must also meet the current mandatory features.

## Additions and Alterations Alone Method

The simplest method for showing energy compliance for the building addition or alteration is analyzing it alone, and ignoring the existing building. This method is most effective when the energy features correspond closely to the package D requirements (see *Residential Manual*, Appendix B, Table 151-C) for the climate zone where the building is located.

☞ ***NOTE – Shut Off Water Heating:*** *It is acceptable to add a water heater as part of an addition, however, water heating systems may not be modeled when using the Additions Alone method. Water heating calculations are skipped by setting WATER HEATING CALCULATIONS to 'No' in the Calculation and Reports Section of input data.*

*When adding a water heater in an AdditionAlone, see Residential Manual, Section 8.5.2 for more information.*

If compliance cannot be achieved using the Addition Alone method, expand the analysis to include the energy features of the existing building (see discussion of Existing + Addition + Alteration Analysis).

☞ ***NOTE - Packages****: If the addition is* $\leq$ *100ft*$^2$ *and has* $\leq$ *50ft*$^2$ *of glazing, consider the package approach. See Section 8.3.2 of the Residential Manual for details.*

Except for the inputs mentioned below, the Addition Alone method requires the addition to be modeled and documented as a separate building. The existing house (including any wall or glazing between the existing house and the addition) is ignored. Set the CONSTRUCTION TYPE under the RUN FEATURES menu to 'AdditionAlone'.

*Internal Heat Gain Adjustment:* Internal heat gain (due to occupants and appliances) is calculated by MICROPAS based on the number of dwelling units. An addition is treated as a fraction of the entire dwelling unit(s). The input NUMBER OF DWELLING UNITS under ZONE must be adjusted to reflect the fractional internal gains for the addition alone. The formula for this adjustment is as follows:

NUMBER OF DWELLING UNITS =

$$(\text{UNITS} \times FA_{add}) / (FA_{add} + FA_{exist})$$

where:

UNITS = number of dwelling units in the building

$FA_{add}$ = floor area of the addition only

$Fa_{exist}$ = floor area of the existing house only

## Existing + Addition + Alteration Method

**Overview** The proposed house (including existing, deleted, altered and new (added) features) must meet an energy budget goal. This goal is based upon a comparison of the existing building, along with any additions and alterations, to the standards following a detailed set of rules that are included in MICROPAS. Depending on the features and climate zones specified, MICROPAS automatically does one or more runs in accordance with the rules. Compliance results are detailed on a single CF-1R that describes the building both before and after the addition and/or alterations.

The user describes the existing building with all additions and/or alterations in a single input file using tags.

**Tags** When modeling Existing + Addition + Alteration, MICROPAS uses tags (see Keyboard Shortcuts below) to determine what effect (credit, penalty or neutral) that feature has on determining the energy budget for the proposed construction. Tags are used on names in the zone, opaque, glazing, inter-zone, mass and water heating sections. A sample of inputs with tags is shown in Figure 3-2.

- Existing (/E or no tag)

  Specifies existing features that describe the building as it is constructed before the addition and/or alteration. Used for existing features that will remain after all construction is complete, or that will be altered as part of the construction. If a feature is to be deleted as part of the construction, use the /D tag instead.

- Altered (/A)

  Specifies features that are altered as part of the construction. Altered features must be paired with a corresponding existing feature. Input the existing feature first, followed immediately (next Zone or next line) by the altered feature.

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- Deleted (/D)

  Specifies existing features that are deleted as part of the addition and/or alteration. When a wall or window, for example, will be removed, include the surface with a /D after the name.

- New (/N)

  Specifies features that are new (added) as part of the addition or alteration.

☞ ***NOTE – Altered Features:*** *It is essential that the use of /A for a building feature immediately follows a line (or zone) of the same name. If it does not have the same name and, when appropriate, other properties like area or orientation, an error message will be generated when the file is run.*

☞ ***KEYBOARD SHORTCUT****: In edit mode (press enter once), press Alt-A, Alt-D, Alt-E, or Alt-N to automatically append the name to include the appropriate tag that tells MICROPAS how to treat this surface.*

*Figure 3-2. Tags*

OPAQUE SURFACES

| | OPAQUE SURFACE NAME | AREA OR LENGTH | TILT | PLAN AZIMUTH | SOLAR GAINS (Y/N) | OPAQUE CHARACTERISTICS | ZONE OR OPAQUE NAME | LOCATION/ COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | ——1—— | ——2—— | ——3—— | ——4—— | ——5—— | ———6——— | ——7—— | ———8——— |
| 1> | FW | 196 | Vert | Front | Yes | E.WALL | HOUSE | |
| 2> | FW/A | 196 | Vert | Front | Yes | WALL.R13.16 | HOUSE | |
| 3> | FWA/N | 88 | Vert | Front | Yes | WALL.R13.16 | ADD/N | |
| 4> | LWD/D | 288 | Vert | Left | Yes | E.WALL | HOUSE | |
| 5> | LWA/N | 176 | Vert | Left | Yes | WALL.R13.16 | ADD/N | |
| 6> | BW | 208 | Vert | Back | Yes | E.WALL | HOUSE | |
| 7> | BWD/D | 96 | Vert | Back | Yes | E.WALL | HOUSE | |

GLAZING SURFACES

| | GLAZING SURFACE NAME | AREA (sf) | TILT | PLAN AZIMUTH | GLAZING CHARACTERISTICS | OVERHANG SIDE FIN NAME | INT/EXT SHADE NAME | ZONE OR OPAQUE NAME |
|---|---|---|---|---|---|---|---|---|
| | ——1—— | ——2—— | ——3—— | ——4—— | ———5——— | ——6—— | ——7—— | ——8—— |
| 5> | F3 | 16 | Vert | Front | SG.ALUM | None | STANDARD | FW |
| 6> | F3/A | 16 | Vert | Front | VW.OP | None | STANDARD | FW |
| 7> | F4/N | 12 | Vert | Front | VW.OP | None | STANDARD | FWA/N |
| 8> | L1/D | 12 | Vert | Left | SG.ALUM | None | STANDARD | LWD/D |
| 9> | L2/N | 4 | Vert | Left | VW.OP | None | STANDARD | LWA/N |
| 10> | L3/N | 20 | Vert | Left | VW.DR | None | STANDARD | LWA/N |

### Input Assumptions for Existing House

The following information must be gathered to perform an analysis on the existing building:

- Year of original construction (also called vintage)
- Floor, ceiling, wall and glazing areas
- Insulation levels
- Glazing type (single, double), frame type, shading and orientations
- HVAC equipment efficiencies
- Water heating system(s)
- Duct location
- Other data as needed

If the existing house conservation features are not known, use the assumptions listed in Table 3-2 for the year in which the building was originally built (or permitted).

☞ ***NOTE - Year Built:*** *If the building has a previously constructed addition, the vintage or year of construction is the year the addition was permitted. This is to account for any improvements made as part of an existing plus addition analysis at the time of the addition.*

☞ ***NOTE - Existing Heating System and Addition****: if you are extending an existing heating system, the system must be large enough to accommodate the addition.*

☞ ***NOTE – Credit for Past Improvements****: If a building had improvements that were made after it was constructed, and documentation exists to verify the improvements, how this upgrade is modeled depends on whether the improvement meets or exceeds current prescriptive alteration requirements (typically Package D).*

*If the upgrade is equal or better than Package D, to receive a credit for this improvement model the unimproved feature first (/E) followed by the improved feature as an alteration (/A).*

*However, if a past upgrade does not meet or exceed current alteration requirements (e.g., walls were insulated to R-11 in the 1980s, ceiling insulated to R-19) model the upgraded feature as existing (either /E or no tag).*

*Any upgrade that is planned as part of the current construction, whether it meets current alteration requirements or not, must be modeled as altered (/A).*

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*Table 3-2. Default Assumptions for Existing Buildings*

| | Default Assumption for Year Built (Vintage) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Conservation Measure** | **Before 1978** | **1978 to -83** | **1984 to-91** | **1992 to 98** | **1999 to 2000** | **2001 to 03** | **2004 to 05** | **2006 & later** |
| INSULATION (U-VALUE) | | | | | | | | |
| Roof | 0.079 | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 |
| Wall | 0.356 | 0.110 | 0.110 | 0.102 | 0.102 | 0.102 | 0.102 | 0.102 |
| Raised Floor-Crawlspace | 0.099 | 0.099 | 0.099 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 |
| Raised Floor-No Crawlspace | 0.238 | 0.238 | 0.238 | 0.064 | 0.064 | 0.064 | 0.064 | 0.064 |
| Slab Edge F2 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 |
| Ducts | R-2.1 | R-2.1 | R-2.1 | R-4.2 | R-4.2 | R-4.2 | R-4.2 | R-4.2 |
| LEAKAGE | | | | | | | | |
| Building (SLA) | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 |
| Duct Leakage Factor | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.89 | 0.89 | 0.89 |
| FENESTRATION | | | | | | | | |
| U-factor | Use Standards Table 116A for all vintages (see Table 2-4, Ch. 2, Input Reference) | | | | | | | |
| SHGC | Use Standards Table 116B for all vintages (see Table 2-5, Ch. 2, Input Reference) | | | | | | | |
| Shading Device | Use ACM Table R3-7 (see Table 2-7, Ch. 2, Input Reference) | | | | | | | |
| SPACE HEATING EFFICIENCY | | | | | | | | |
| Gas Furnace (Central), AFUE | 0.75 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| Heat Pump, HSPF | 5.6 | 5.6 | 6.6 | 6.6 | 6.8 | 6.8 | 6.8 | 7.4 |
| Electric Resistance, HSPF | 3.413 | 3.413 | 3.413 | 3.413 | 3.413 | 3.413 | 3.413 | 3.413 |
| SPACE COOLING EFFICIENCY | | | | | | | | |
| All Types, SEER | 8.0 | 8.0 | 8.9 | 9.7 | 9.7 | 9.7 | 9.7 | 12.0 |
| WATER HEATING | | | | | | | | |
| Energy Factor | 0.525 | 0.525 | 0.525 | 0.525 | 0.58 | 0.58 | 0.575 | 0.575 |
| Rated Input (MBH) | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 |

This table is based on Table R3-11 in the *Residential ACM Approval Manual*.

### Modeling an Existing + Addition + Alteration

Collect information from the plans and specifications about the building as originally constructed, upgrades or additions made since that time, and the currently proposed construction. Using the tags, enter the data necessary to describe each feature in both its current state and when construction is complete.

Model the floor area of the addition as a separate zone. Set the number of dwelling units in both the addition zone and the existing zone to the fraction of the dwelling units similar to the description above for addition alone calculations. If the home is a single dwelling unit, the number of dwelling units for the existing plus addition should add to 1. If any features of the existing building that are modeled in ZONE will change (e.g., upgraded HVAC equipment), model the existing zone first, followed immediately by the altered zone (same name with /A).

Include all proposed upgrades to the existing building as an alteration (/A). See note above for modeling past improvements.

It is important to model features that will be removed as part of the new construction (/D), because this affects the energy budget. New water heating equipment, walls, glazing and mass are modeled with a /N tag, while new floor area and HVAC equipment will be modeled in a zone with a /N tag. See Figure 3-4 for a sample of how these tags affect the output on the CF-1R form.

Enter 'Existing+Add+Alter' for the CONSTRUCTION TYPE, and select the year of construction (ranging from Before 1978 to current year), in the RUN FEATURES menu.

Figure 3-3 shows additional examples of an input file for an existing plus addition plus alteration. Figure 3-4 shows an example of the output.

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*Figure 3-3. Existing Plus Addition Plus Alteration Inputs*

```
RUN FEATURES
____________

RUN
 1> RUN TITLE (25 char) ............................. Sample E+A+A

BUILDING
5> CONSTRUCTION (New, Existing+Add+Alter, etc) ..... Existing+Add+Alter
14> VINTAGE ASSUMPTIONS FOR EXISTING BUILDING ...... Before 1978

ZONES
_____

 #> NUMBER OF ZONES (15 maximum) ..................... 3
 1> ZONE ............................................ HOUSE
 2> ZONE ............................................ HOUSE/A
 3> ZONE ............................................ ADD/N

ZONE 'HOUSE'
____________

 1> ZONE NAME ....................................... HOUSE
 2> CONDITIONED (Yes, No) ........................... Yes
 3> ZONE TYPE ....................................... Residence
 4> FLOOR AREA (sf) ................................. 1005
 5> VOLUME (cuft) ................................... 8040
 6> NUMBER OF DWELLING UNITS ........................ 1
HVAC SYSTEM
 10> NUMBER OF SYSTEMS SERVING ZONE ................. 1
 11> HEATING SYSTEM NAME ............................ FURN.75
 12> COOLING SYSTEM NAME ............................ AC.8.0
 13> DUCT SYSTEM NAME ............................... ATTIC.R4.2

ZONE 'HOUSE/A'
______________

 1> ZONE NAME ....................................... HOUSE/A
 2> CONDITIONED (Yes, No) ........................... Yes
 3> ZONE TYPE ....................................... Residence
 4> FLOOR AREA (sf) ................................. 1005
 5> VOLUME (cuft) ................................... 8040
 6> NUMBER OF DWELLING UNITS ........................ 0.63
HVAC SYSTEM
 10> NUMBER OF SYSTEMS SERVING ZONE ................. 1
 11> HEATING SYSTEM NAME ............................ FURN.90
 12> COOLING SYSTEM NAME ............................ AC.13
 13> DUCT SYSTEM NAME ............................... ATTIC.R4.2
```

*Figure 3-3. Existing Plus Addition Plus Alteration Inputs (cont'd)*

```
ZONE 'ADD/N'
 1> ZONE NAME ..................................... ADD/N
 2> CONDITIONED (Yes, No) ......................... Yes
 3> ZONE TYPE ..................................... Residence
 4> FLOOR AREA (sf) ............................... 594
 5> VOLUME (cuft) ................................. 4752
 6> NUMBER OF DWELLING UNITS ...................... 0.37
HVAC SYSTEM
 10> NUMBER OF SYSTEMS SERVING ZONE ................ 1
 11> HEATING SYSTEM NAME ........................... FURN.90
 12> COOLING SYSTEM NAME ........................... AC.13
 13> DUCT SYSTEM NAME .............................. ATTIC.R4.2

OPAQUE SURFACES
 #> NUMBER OF SURFACES (100 maximum) ................ 17
      OPAQUE   AREA                  SOLAR OPAQUE        ZONE OR
      SURFACE  OR            PLAN    GAINS CHARAC-       OPAQUE   LOCATION/
      NAME     LENGTH TILT   AZIMUTH (Y/N) TERISTICS     NAME     COMMENTS
      ---1---- --2--- --3-- ---4--- --5-- -------6------- ---7---- --------8--------
 1>   FW       196    Vert   Front   Yes   E.WALL         HOUSE
 2>   FW/A     196    Vert   Front   Yes   WALL.R13.16    HOUSE
 3>   FWA/N    88     Vert   Front   Yes   WALL.R13.16    ADD/N
 4>   LWD/D    288    Vert   Left    Yes   E.WALL         HOUSE
 5>   LWA/N    176    Vert   Left    Yes   WALL.R13.16    ADD/N
 6>   BW       208    Vert   Back    Yes   E.WALL         HOUSE
 7>   BWD/D    96     Vert   Back    Yes   E.WALL         HOUSE
 8>   BWA/N    288    Vert   Back    Yes   WALL.R13.16    ADD/N
 9>   RW       288    Vert   Right   Yes   E.WALL         HOUSE
 10>  GWA/N    264    Vert   n/a     No    WALL.R13.16    ADD/N
 11>  FD       20     Vert   Front   Yes   DOOR           FW
 12>  LDD/D    17.8   Vert   Left    Yes   DOOR           LWD/D
 13>  GDA/N    17.8   Vert   n/a     No    DOOR           GWA/N
 14>  R        1005   Horz   n/a     Yes   E.ROOF         HOUSE
 15>  RA/N     594    Horz   n/a     Yes   ROOF.R30.24    ADD/N
 16>  E        123    Horz   n/a     No    EDGE.EXT       HOUSE
 17>  EA/N     102    Horz   n/a     No    EDGE.EXT       ADD/N

GLAZING SURFACES
 #> NUMBER OF SURFACES (100 maximum) ................ 20
      GLAZING                        GLAZING       OVERHANG  INT/EXT   ZONE OR
      SURFACE  AREA          PLAN    CHARAC-       SIDE FIN  SHADE     OPAQUE
      NAME     (sf)   TILT  AZIMUTH TERISTICS     NAME      NAME      NAME
      ---1---- --2--- --3-- ---4--- -------5------- -----6---- -----7---- ---8----
 5>   F3       16     Vert  Front   SG.ALUM       None      STANDARD  FW
 6>   F3/A     16     Vert  Front   VW.OP         None      STANDARD  FW
 7>   F4/N     12     Vert  Front   VW.OP         None      STANDARD  FWA/N
 8>   L1/D     12     Vert  Left    SG.ALUM       None      STANDARD  LWD/D
 9>   L2/N     4      Vert  Left    VW.OP         None      STANDARD  LWA/N
 10>  L3/N     20     Vert  Left    VW.DR         None      STANDARD  LWA/N
 11>  B1       16     Vert  Back    SG.ALUM       None      STANDARD  BW
 12>  B1/A     16     Vert  Back    VW.OP         None      STANDARD  BW
 13>  B2/N     16     Vert  Back    VW.OP         None      STANDARD  BWA/N
 14>  B3/N     20     Vert  Back    VW.OP         None      STANDARD  BWA/N

MASS SURFACES
 #> NUMBER OF SURFACES (50 maximum) ................. 2
      MASS               MASS
      SURFACE   AREA     CHARAC-       ZONE
      NAME      (sf)     TERISTICS     NAME      LOCATION/COMMENTS
      ----1---- ---2---- -------3------ ----4---- ----------5----------
 1>   SLAB      1005     SLAB.CVR      HOUSE
 2>   SLABA/N   594      SLAB.CVR      ADD/N

WATER HEATING SYSTEMS
 #> NUMBER OF WATER HEATING SYSTEMS (25 maximum) .... 2
      WATER          WATER                          # OF             HYDRONIC/
      HEATING        HEATING        HEATER/BOILER   HEATERS/BOILERS  RECIRC
      NAME           TYPE           SYSTEM NAME     INSTALLED        SYSTEM NAME
      -------1------- -------2------- -------3------- --------4-------- -------5-------
 1>   DHW            DHW            EGAS.50         1                None
 2>   DHW/A          DHW            BOILER.INST     1                None
```

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**What to Submit**

Compliance for an addition or alteration requires a Certificate of Compliance that shows a positive compliance margin. The CF-1R along with the MF-1R form is all that is required for compliance. See Figure 3-4 for a sample of a CF-1R using Existing Plus Addition Plus Alteration compliance with the appropriate tags.

*Figure 3-4. Existing Plus Addition Plus Alteration Printouts*

BUILDING ZONE INFORMATION

| Zone Type | Floor Area (sf) | Volume (cf) | # of Dwell Units | # of Peop-le | Cond-it-ioned | Thermo-stat Type | Vent Height (ft) | Vent Area (sf) | Verified Leakage or Housewrap |
|---|---|---|---|---|---|---|---|---|---|
| HOUSE - Existing | | | | | | | | | |
| Residence | 1005 | 8040 | 1.00 | 4.0 | Yes | Setback | 2.0 | Standard | No |
| HOUSE - Altered | | | | | | | | | |
| Residence | 1005 | 8040 | 0.63 | 2.5 | Yes | Setback | 2.0 | Standard | No |
| ADD - New (Added) | | | | | | | | | |
| Residence | 594 | 4752 | 0.37 | 1.5 | Yes | Setback | 2.0 | Standard | No |

OPAQUE SURFACES

| Surface | Frame Type | Area (sf) | U-fact-or | Cavity R-val | Sheath-ing R-val | Act Azm | Tilt | Solar Gains | Appendix IV Reference | Location/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| HOUSE - Existing | | | | | | | | | | |
| 1 Wall | Wood | 48 | 0.356 | 0 | 0 | 270 | 90 | Yes | IV.9 A1 | |
| 6 Wall | Wood | 176 | 0.356 | 0 | 0 | 90 | 90 | Yes | IV.9 A1 | |
| 9 Wall | Wood | 208 | 0.356 | 0 | 0 | 180 | 90 | Yes | IV.9 A1 | |
| 11 Door | Other | 20 | 0.500 | 0 | 0 | 270 | 90 | Yes | IV.5 A4 | |
| 14 Roof | Wood | 1005 | 0.079 | 0 | 0 | n/a | 0 | Yes | IV.1 A2 | |
| HOUSE - Altered | | | | | | | | | | |
| 2 Wall | Wood | 196 | 0.102 | 13 | 0 | 270 | 90 | Yes | IV.9 A3 | |
| HOUSE - Deleted | | | | | | | | | | |
| 4 Wall | Wood | 258 | 0.356 | 0 | 0 | 0 | 90 | Yes | IV.9 A1 | |
| 7 Wall | Wood | 96 | 0.356 | 0 | 0 | 90 | 90 | Yes | IV.9 A1 | |
| 12 Door | Other | 18 | 0.500 | 0 | 0 | 0 | 90 | Yes | IV.5 A4 | |
| ADD - New (Added) | | | | | | | | | | |
| 3 Wall | Wood | 76 | 0.102 | 13 | 0 | 270 | 90 | Yes | IV.9 A3 | |
| 5 Wall | Wood | 152 | 0.102 | 13 | 0 | 0 | 90 | Yes | IV.9 A3 | |
| 8 Wall | Wood | 215 | 0.102 | 13 | 0 | 90 | 90 | Yes | IV.9 A3 | |
| 10 Wall | Wood | 246 | 0.102 | 13 | 0 | 270 | 90 | No | IV.9 A3 | |
| 13 Door | Other | 18 | 0.500 | 0 | 0 | 270 | 90 | No | IV.5 A4 | |
| 15 Roof | Wood | 594 | 0.032 | 30 | 0 | n/a | 0 | Yes | IV.1 A7 | |

FENESTRATION SURFACES

| Orientation | Area (sf) | U-factor | SHGC | Act Azm | Tilt | Exterior Shade Type | Location/Comments |
|---|---|---|---|---|---|---|---|
| HOUSE - Existing | | | | | | | |
| 1 Wind Front (W) | 24.0 | 1.280 | 0.800 | 270 | 90 | Standard | F1/Alum Single Operable |
| 3 Wind Front (W) | 24.0 | 1.280 | 0.800 | 270 | 90 | Standard | F2/Alum Single Operable |
| 5 Wind Front (W) | 16.0 | 1.280 | 0.800 | 270 | 90 | Standard | F3/Alum Single Operable |
| 11 Wind Back (E) | 16.0 | 1.280 | 0.800 | 90 | 90 | Standard | B1/Alum Single Operable |
| 17 Wind Right (S) | 16.0 | 1.280 | 0.800 | 180 | 90 | Standard | R1/Alum Single Operable |
| 19 Wind Right (S) | 24.0 | 1.280 | 0.800 | 180 | 90 | Standard | R2/Alum Single Operable |
| HOUSE - Altered | | | | | | | |
| 2 Wind Front (W) | 24.0 | 0.600 | 0.650 | 270 | 90 | Standard | F1/Vinyl Oper Default |
| 4 Wind Front (W) | 24.0 | 0.600 | 0.650 | 270 | 90 | Standard | F2/Vinyl Oper Default |
| 6 Wind Front (W) | 16.0 | 0.600 | 0.650 | 270 | 90 | Standard | F3/Vinyl Oper Default |
| 12 Wind Back (E) | 16.0 | 0.600 | 0.650 | 90 | 90 | Standard | B1/Vinyl Oper Default |
| 18 Wind Right (S) | 16.0 | 0.600 | 0.650 | 180 | 90 | Standard | R1/Vinyl Oper Default |
| 20 Wind Right (S) | 24.0 | 0.600 | 0.650 | 180 | 90 | Standard | R2/Vinyl Oper Default |
| HOUSE - Deleted | | | | | | | |
| 8 Wind Left (N) | 12.0 | 1.280 | 0.800 | 0 | 90 | Standard | L1/Alum Single Operable |
| ADD - New (Added) | | | | | | | |
| 7 Wind Front (W) | 12.0 | 0.600 | 0.650 | 270 | 90 | Standard | F4/Vinyl Oper Default |
| 9 Wind Left (N) | 4.0 | 0.600 | 0.650 | 0 | 90 | Standard | L2/Vinyl Oper Default |
| 10 Door Left (N) | 20.0 | 0.550 | 0.650 | 0 | 90 | Standard | L3/Vinyl/Wood Door Defau |
| 13 Wind Back (E) | 16.0 | 0.600 | 0.650 | 90 | 90 | Standard | B2/Vinyl Oper Default |
| 14 Wind Back (E) | 20.0 | 0.600 | 0.650 | 90 | 90 | Standard | B3/Vinyl Oper Default |
| 15 Door Back (E) | 33.4 | 0.550 | 0.650 | 90 | 90 | Standard | B4/Vinyl/Wood Door Defau |
| 16 Wind Back (E) | 4.0 | 0.600 | 0.650 | 90 | 90 | Standard | B5/Vinyl Oper Default |

*Figure 3-4. Existing Plus Addition Plus Alteration Printouts (cont'd)*

HVAC SYSTEMS

| System Type | Number of Systems | Minimum Efficiency | Verified EER | Verified Refrig Charge or TXV | Verified Adequate Airflow | Verified Fan Watt Draw | Verified Maximum Cooling Capacity |
|---|---|---|---|---|---|---|---|
| HOUSE - Existing | | | | | | | |
| Furnace | 1 | 0.750 AFUE | n/a | n/a | n/a | n/a | n/a |
| ACSplit | 1 | 8.00 SEER | No | No | No | No | No |
| HOUSE - Altered | | | | | | | |
| Furnace | 1 | 0.900 AFUE | n/a | n/a | n/a | n/a | n/a |
| ACSplit | 1 | 13.00 SEER | No | Yes | No | No | No |
| ADDTN - New (Added) | | | | | | | |
| Furnace | 1 | 0.900 AFUE | n/a | n/a | n/a | n/a | n/a |
| ACSplit | 1 | 13.00 SEER | No | Yes | No | No | No |

WATER HEATING SYSTEMS

| Tank Type | Heater Type | Distribution Type | Number in System | Energy Factor | Tank Size (gal) | External Insulation R-value |
|---|---|---|---|---|---|---|
| DHW - Deleted | | | | | | |
| 1 Storage | Gas | Standard | 1 | 0.525 | 50 | R-12 |
| DHW - New (Added) | | | | | | |
| 2 Instantaneous | Gas | Standard | 1 | n/a | n/a | R-n/a |

## Special Modeling Rules

Additions and alterations typically have special rules for modeling to avoid an undue energy penalty. These modeling assumptions may result in a HERS verification note on the Certificate of Compliance.

☞ ***NOTE - Existing HVAC systems****: The recommended modeling procedures that follow will result in a HERS Verification Required note on the CF-1R. It will be up to the documentation author to show that such measure(s) are modeling assumptions only.*

**Refrigerant Charge (RC)**

Additions and alterations typically have special rules for modeling to avoid an undue energy penalty (see Table 3-3). Whether to model Verified Refrigerant Charge (RC) in additions and alterations depends on the type of compliance approach and the proposed changes to the HVAC system (duct systems are discussed below).

The general guideline is when additions and alterations use existing equipment for space conditioning, the existing building zone and the addition zone use current Package D assumptions for the HVAC system to avoid an energy penalty.

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*Table 3-3. Verified Refrigerant Charge (RC) (or TXV) Assumptions for Additions*

| Compliance Approach | HVAC Equipment | RC Modeling Assumptions: Existing Building Zone | RC Modeling Assumptions: Addition Zone |
|---|---|---|---|
| Addition[1] alone | Existing | n/a | Pkg D[2] |
| Addition alone | New | n/a | Actual |
| Existing + Addition | Existing | Pkg D[2] | Pkg D[2] |
| Existing (E) + Addition (A) | New in addition only | Table 3-2[3] | Actual for A<br>Table 3-2 for E |
| Existing (E) + Addition (A) | New in whole bldg | Table 3-2[3] | Actual for E+A |

1. Addition includes alteration
2. Package D in Zones 2 and 8-15 is 13 SEER with Verified Refrigerant or TXC
   Package D in Zones 1, 3-7 and 16 is 13 SEER

Enter the appropriate efficiency from the Vintage Table 3-2.

**Verified Leakage**

*Existing ducts:* Model the existing duct system with Verified Leakage set to either 'No', 'Pre2001' if the existing ducts were constructed prior to 2001 and do not have verified leakage, or 'Existing' if the existing ducts had verified leakage testing.

*Extended ducts:* If ducts are being extended to serve the existing plus addition/alteration, include the extended duct in a separate zone with a tag /E (e.g., R4.2/E).

*New duct system:* If the addition/alteration will have a completely separate and new duct system, model the new or altered zone with the duct construction proposed.

*No new ducts:* If no new ducts will be installed in an addition (e.g., a wall is being moved out a few feet without creating any new habitable rooms), the input file for the 'AdditionAlone' proposed building can include verified leakage (i.e., Package D assumption for existing conditions). This will, however, trigger a HERS verification notice on the CF-1R.

☞ ***NOTE – Altering HVAC systems****: Most changes to the HVAC system trigger a prescriptive requirement for tested ducts (which also affects the Standard Design for performance compliance).*

**Partial credits**

To model credit for cool roof or radiant barrier in only a portion of a dwelling, such as in an addition, model each attic/roof condition as a separate zone.

# Multiple Conditioned Zones

This section describes how to analyze two specialized conditions:

1. Zonally controlled HVAC systems, which receive compliance credit.

2. Multiple zones in a single building without zonal control credit.

# Zonally Controlled HVAC Systems

Certain HVAC systems have the ability to condition multiple zones within a single dwelling unit. These systems are called Zonally Controlled HVAC Systems and may receive compliance credit when they meet specific CEC requirements. Zonally controlled systems can save energy by allowing the occupant to setback unoccupied areas of the building, while keeping occupied areas within the desired heating and cooling thermostat setpoints. This control may be achieved with multiple HVAC systems or a single system with the ability to control multiple zones separately. The discussion in this section is for a single-family dwelling.

**Eligibility and Installation Criteria**

There are unique CEC eligibility and installation requirements that must be met in order to use this modeling technique. A key requirement is a maximum non-closeable opening between the two zones of 40 square feet. This requirement is to limit the amount of air migrating from the conditioned zone into the unconditioned zone. All of the requirements are described in detail in Chapter 8 of the *Residential Manual.*

**Example Input File**

An example input data file for a zonally controlled HVAC system is provided as part of MICROPAS with the file name 'MP7ZONAL'.

## Input Data For Zonally Controlled HVAC Systems

**Defining the Zones**

The zonally controlled HVAC system is modeled by dividing the building into two types of zones—living and sleeping (regardless of how many zones the actual system is serving). The Living Zone is the area that is normally occupied during waking hours. It includes the kitchen, den, living room and dining room. The Sleeping Zone includes bedrooms. Hallways, bathrooms, pantries and laundry rooms (which are either non-habitable or indirectly conditioned space) can be included in either zone, depending on their location.

In most cases there is only one Living and one Sleeping Zone. In larger houses however, there may be multiple HVAC systems, each serving one of several zones, all of which are defined as either a Living or Sleeping Zone.

MICROPAS incorporates the CEC fixed internal heat gain and thermostat setting assumptions for the two zones. These represent active daytime occupation of the Living Zone and non-active night-time occupation of the Sleeping Zone. The exact assumptions of this model are described in Appendix E, Program Assumptions.

Figure 3-5 illustrates the ZONE Section input data for Living and Sleeping Zones. The input values ZONE TYPE must be set to 'Living' and 'Sleeping', and the input values THERMOSTAT TYPE must be set to 'LivingStat' and 'SleepingStat' as shown.

For the Living Zone, the input value NUMBER OF DWELLING UNITS is set to the actual number of dwelling units in the building. For the Sleeping Zone, it is set to '0'.

In the case of a large house with multiple HVAC systems, there may be multiple Living or Sleeping Zones. In order to properly size the mechanical equipment, it may be necessary to consider each zone served by an independent system separately. In such cases, adjust the NUMBER OF DWELLING UNITS for each type of zone. For multiple Living Zones, area weight the square footage of all of the living zones and input a fractional value for NUMBER OF DWELLING UNITS for each zone. The total NUMBER OF DWELLING UNITS in all the Living Zones must add up to '1'. For Sleeping Zones, always input '0'.

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*Figure 3-5. Zone Input Data for Zonal Control*

```
ZONE 'LIVING'

 1> ZONE NAME ..................................... LIVING
 2> CONDITIONED (Yes, No) ......................... Yes
 3> ZONE TYPE ..................................... Residence
 4> FLOOR AREA (sf) ............................... 1000
 5> VOLUME (cuft) ................................. 10000
 6> NUMBER OF DWELLING UNITS ...................... 1
CREDITS
 7> HOUSEWRAP/VERIFIED AIR LEAKAGE (Yes,No,SLA) ..... No
 8> RADIANT BARRIER (Yes, No, CoolRoof) ............. Yes
 9> VERIFIED INSULATION QUALITY (Yes, No) ........... No
HVAC SYSTEM
 10> NUMBER OF SYSTEMS SERVING ZONE ................. 1
 11> HEATING SYSTEM NAME ........................... FURN.80
 12> COOLING SYSTEM NAME ........................... AC.13.0.TXV
 13> DUCT SYSTEM NAME .............................. R6.0.TEST
 14> NATURAL VENTILATION SYSTEM NAME ............... ONE.STORY
 15> FAN VENTILATION SYSTEM NAME ................... None
 16> THERMOSTAT NAME ............................... LivingStat
HVAC SIZING
 17> NUMBER OF PEOPLE/UNIT (occupants/unit) ......... 4
 18> APPLIANCE GAIN/UNIT  (Btuh/unit) ............... 1000
 19> INFILTRATION CLASS (Tight, Medium, Loose) ...... Medium
```

## Opaque Surface Zone Identification

For buildings that have multiple zones defined, all surfaces must be assigned to a zone by entering the appropriate zone in the ZONE OR OPAQUE NAME section of the OPAQUE SURFACES menu (see Figure 3-6). When using the *net area* method for GLAZING SURFACES (i.e., the ZONE OR OPAQUE NAME is HOUSE rather than an opaque surface name), select a zone (LIVING or SLEEPING) for each glazing surface described. See the Glazing section in Chapter 2, Input Reference for more details.

*Figure 3-6. Zone Input Data for Opaque Surfaces*

```
OPAQUE SURFACES

#> NUMBER OF SURFACES (100 maximum) ................. 12
      OPAQUE   AREA                  SOLAR OPAQUE         ZONE OR
      SURFACE  OR              PLAN  GAINS CHARAC-        OPAQUE   LOCATION/
      NAME     LENGTH TILT  AZIMUTH (Y/N) TERISTICS      NAME     COMMENTS
      ---1---- --2--- --3-- ---4--- --5-- -------6------- ---7---- --------8--------
 1>   FWALL    188    Vert  Front   Yes   WALL.R13       LIVING
 2>   FSWALL   188    Vert  Front   Yes   WALL.R13       SLEEPING
 3>   LWALL    188    Vert  Left    Yes   WALL.R13       LIVING
 4>   LSWALL   100    Vert  Left    Yes   WALL.R13       SLEEPING
 5>   BWALL    120    Vert  Back    Yes   WALL.R13       LIVING
 6>   BSWALL   200    Vert  Back    Yes   WALL.R13       SLEEPING
 7>   RWALL    320    Vert  Right   Yes   WALL.R13       LIVING
 8>   CWALL    45     Vert  45      Yes   WALL.R13       LIVING   Corner Wall
 9>   ROOF     1000   Horz  n/a     Yes   ROOF.R38.16    LIVING
 10>  ROOFS    600    Horz  n/a     Yes   ROOF.R38.16    SLEEPING
 11>  FDOOR    20     Vert  Front   Yes   DOOR           FWALL
 12>  EEDGE    160    n/a   n/a     No    EDGE.EXT       LIVING

MASS SURFACES

      MASS              MASS
      SURFACE   AREA    CHARAC-       ZONE
      NAME      (sf)    TERISTICS     NAME      LOCATION/COMMENTS
      ----1---- --2--- -------3------- ----4---- ----------5----------
 1>   CVR.SLAB  1000    SLAB.CVR      LIVING
 2>   CVR.SLBS  600     SLAB.CVR      SLEEPING
 3>   TILEVERT  0       VTILE.1.0     LIVING    Tile Walls
 4>   TILEHORZ  0       HTILE.1.0     LIVING    Tile Floor
 5>   MASSWALL  0       RETWALL.X.E   LIVING    Exp.Ext.Retaining Wall
```

**Interior Surfaces Between Zones**

All surfaces between the two zones must be modeled in the Inter-Zone Surface Section of input. This includes all floors, walls, doors and ceilings that separate the two zones. U-values commonly used are:

- Doors = '0.50'
- Uninsulated framed walls, floors and ceilings = '0.293'
- Non-closeable openings = '20.0'
- Glass = 1.10

Figure 3-7 provides an example of inputs for surfaces between zones.

*Figure 3-7. Inter-Zone Input Data for Zonal Control*

INTER-ZONE SURFACES

| | INTERIOR SURFACE NAME (1) | AREA (sf) (2) | OPAQUE CHARAC-TERISTIC (3) | ZONE SIDE #1 (4) | ZONE SIDE #2 (5) | LOCATION/ COMMENTS (6) |
|---|---|---|---|---|---|---|
| 1> | WALL | 256 | WALL.INT | LIVING | SLEEPING | |
| 2> | OPEN | 32 | OPENING | LIVING | SLEEPING | |

OPAQUE CHARACTERISTICS

| | OPAQUE CHARAC-TERISTIC (1) | OPAQUE SURFACE TYPE (2) | FRAME TYPE (3) | CAV-ITY R-VAL (4) | SHEATH-ING R-VAL (5) | U-VAL OR F-VAL (6) | APP IV LOOKUP (7) | APPENDIX IV LOOKUP NAME (8) |
|---|---|---|---|---|---|---|---|---|
| 14> | WALL.INT | Wall | Wood | n/a | n/a | 0.293 | No | NONE |
| 15> | OPENING | Wall | None | n/a | n/a | 20 | No | NONE |

# Multiple Zones without Zonal Control Credit

**Multiple HVAC systems**

Larger homes often have more than one HVAC system, sometimes with different efficiencies. The MICROPAS results are not affected by the number of HVAC systems. Therefore, it is not necessary to model each system as a separate zone, although it may be desirable to obtain load calculations for each zone.

If the system types vary, then it becomes necessary to model multiple zones for multiple HVAC systems. For example a house might have two heat pump systems, one servicing the upstairs and one servicing the downstairs. Another example would be a home with a central furnace with electric resistance baseboards heating a remote portion of the house. This section covers multi-system homes that do not meet the criteria for zonal control credit specified in the *Residential Manual* and discussed in the preceding section.

This method allows modeling the building with two (or more) zones. It allows for the presence of different duct locations that would occur with different HVAC systems serving upstairs and downstairs in a two-story home. It also provides zone heating and cooling loads, which may be useful for equipment selection.

**Interior Surfaces Between Zones**

When credit for zonal control is not being modeled, it is not necessary to model surfaces between zones.

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## Zoning the Building

Divide the building up into two or more zones to accurately reflect the areas of the building with different conditions.

Set the input value NUMBER OF DWELLING UNITS for each zone proportional to its conditioned floor area. For example, a 1500 sf single family home divided into 1200 sf and 300 sf zones would have values of '0.80' (1200 sf/1500 sf) and '0.20' (300 sf/1500 sf) for NUMBER OF DWELLING UNITS.

For buildings with multiple HVAC systems, this technique will allow an HVAC system to be defined for each building zone, each of which can be of any type or efficiency. For buildings with different features, this technique will allow more detailed modeling of building conditions within the parameters of the MICROPAS input file.

# Unconditioned Zones

For residential compliance purposes, most buildings can be modeled as a single conditioned building zone. However, the CEC has approved MICROPAS multiple zone analysis methods for two types of buildings that contain unconditioned zones.

A building may be divided into conditioned and unconditioned zones and modeled for compliance when either:

1. One space is conditioned and another space is unconditioned, as when the house has an attached sunspace. In the case of a sunspace, heat from the sunspace is expected to contribute to the house or reduce heat loss from the house.
2. One space is an unconditioned, uninhabitable "buffer" space (example: controlled ventilation crawlspaces). ***Controlled Ventilation Crawlspaces must meet CEC installation guidelines for compliance as described in Chapter 3 of the Residential Manual.***

## General Unconditioned Zone Concepts

This section describes the general concepts of multiple zone modeling with MICROPAS. Other sections of this manual describe modeling techniques for specific multi-zone building designs.

**Unconditioned Zones**

A zone is modeled as being either conditioned or unconditioned by setting the input value CONDITIONED (in the ZONE Section of input) to 'Yes' or 'No'. The floor area of an unconditioned zone is not included in any of the "conditioned floor area" values calculated by MICROPAS. The input value NUMBER OF DWELLING UNITS is always set to '0'.

**Internal Heat Gains and Heat Capacity**

MICROPAS assumes fixed internal heat gain and zone heat capacity values that vary by the floor area and the number of dwelling units of the zone. These values vary for each type of building zone according to the input value ZONE TYPE in the ZONE Section of input. The numeric values of the internal gain and heat capacity values used by MICROPAS are listed in Appendix E, Program Assumptions.

**Zone Names**

The input value ZONE NAME is defined in the ZONE Section of input. It is used to link surfaces entered in the OPAQUE SURFACES, GLAZING SURFACES, INTER-ZONE SURFACES and MASS SURFACES Sections to a particular building zone.

## Input Data For Inter-zone Ventilation

*Figure 3-8. Inter-Zone Ventilation Input Data*

```
INTER-ZONE VENTILATION SYSTEMS

                VENT            CONTROL     SECONDARY
                SYSTEM          ZONE        ZONE        LOCATION/
      NAME      NAME            NAME        NAME        COMMENTS
      ----1---- -------2------- -----3----- -----4----- ----------5----------
 1>   SSVENT    SUNHOUSE        HOUSE       SUNSPACE

NATURAL VENTILATION SYSTEMS

      NATURAL         NATURAL       INLET      HEIGHT
      VENTILATION     VENTILATION   AREA       DIFF
      SYSTEM NAME     TYPE          PER ZONE   (ft)
      -------1------- ------2------- -----3----- ---4---
 1>   SUNHOUSE        Special       10.0       2.0
```

The inter-zone ventilation model is used to estimate the transfer of heat between two zones, one of which is operated to benefit the other, such as a house with an attached sunspace.

**Control Zone Versus Secondary Zone**

In MICROPAS, an inter-zone ventilation system is assumed to work for the thermal "benefit" of the *control zone* at the thermal "expense" of the *secondary zone.* For example: heat from a sunspace (the secondary zone) is ventilated to the house (the control zone). It is assumed that the occupants of the house will open the doors and windows between the zones to provide heating to the house.

| Input Data | Description: Inter Zone Ventilation |
|---|---|
| *NAME* | Name of inter-zone vent system. Used for identification purposes only. Maximum length is 8 characters. |
| *VENTILATION SYSTEM NAME* | Name which links the inter-zone vent to a ventilation system defined in the Natural Ventilation Section of input. |
| *CONTROL ZONE NAME* | Name of the building zone designated the control zone (see above discussion). This zone must be defined in the ZONE Section of input. Maximum length is 8 characters. |
| *SECONDARY ZONE NAME* | Name of the building zone designated the secondary zone (see above discussion). This zone must be defined in the ZONE Section of input. Maximum length is 8 characters. |
| *LOCATION/ COMMENTS* | Text that describes the location or special features of the inter-zone vent. Maximum length is 20 characters. |

## Input Data For Inter-zone Surfaces

*Figure 3-9. Inter-Zone Surfaces Input Data*

```
INTER-ZONE SURFACES

      INTERIOR            OPAQUE
      SURFACE   AREA      CHARAC-       ZONE       ZONE       LOCATION/
      NAME      (sf)      TERISTIC      SIDE #1    SIDE #2    COMMENTS
      ----1---- ---2---- -------3------- -----4---- -----5---- ----------6----------
 1>   IS1       40        DOUBLE        HOUSE      SUNSPACE   glass to sunspace
 2>   IS2       320       WALL.R11      HOUSE      SUNSPACE   wall to sunspace
```

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| Input Data | Description: Inter Zone Surfaces |
|---|---|

Inter-zone surfaces are used to model walls, windows, ceiling and floors between conditioned and unconditioned building zones.

*INTERIOR SURFACE NAME* — Name of inter-zone surface. Used for identification purposes only by the user. Maximum length is 8 characters.

*AREA* — Area of inter-zone surface. Units: square feet.

*OPAQUE CHARACTERISTICS* — Name which links the properties of an opaque surface characteristic to the inter-zone surface. Maximum length is 12 characteristics.

☞ ***NOTE - Inter-zone Glazing:*** *The characteristics of inter-zone glazing must be defined as a 'Wall', 'Roof', etc. in the OPAQUE CHARACTERISTICS Section of input. You cannot link a glazing characteristic to an inter-zone surface. For example, a single pane glazing could be defined as follows: OPAQUE CHARACTERISTIC NAME = 'SINGLE.GLS', OPAQUE TYPE = 'Wall', R-VALUE = '0', U-FACTOR = '1.28', APP IV LOOKUP 'NO', APPENDIX IV LOOKUP NAME = 'None'.*

*ZONE SIDE #1* — Name of the building zone on side #1 (either zone) of the inter-zone surface. This zone must be defined in the ZONE Section of input. Maximum length is 8 characters.

*ZONE SIDE #2* — Name of the building zone on side #2 (opposite zone of side #1 above) of the inter-zone surface. This zone must be defined in the ZONE Section of input. Maximum length is 8 characters.

*LOCATION/ COMMENTS* — Text describing the location or special features of the inter-zone surface. Maximum length is 20 characters.

## Input Data For Absorbed Insolation Fractions

*Figure 3-10. Absorbed Insolation Fractions Input Data*

```
ABSORBED INSOLATION FRACTIONS

                GLAZING   MASS
     FRACTION   SURFACE   SURFACE   WINTER    SUMMER
     NAME       NAME      NAME      FRACTION  FRACTION
     ----1----- ----2---- ----3---- ----4---- ----5----
 1>  AIF1       SSGLASS1  SUNSLAB   0.3       0.3
 2>  AIF2       SSGLASS2  SUNSLAB   0.3       0.3
 3>  AIF3       SSGLASS3  SUNSLAB   0.3       0.3
```

Absorbed Insolation Fractions (AIF) provide a method of accounting for the benefits of the thermal mass absorbing the incoming solar radiation. By default in MICROPAS, all incoming solar is assumed to be absorbed by the zone air and lightweight mass (such as furniture and the sheetrock on the walls). This is a CEC fixed assumption for all conditioned spaces. For unconditioned zones incorporating passive solar design, the incoming solar can be directed to the various masses in the building. The values stored should be justified by simple calculations of the solar angle and mass surface reflectivity. Incoming solar should never be directed to mass surfaces covered with insulating materials such as carpet or furniture.

☞ ***NOTE - Absorbed Insolation Fractions:*** *Absorbed Insolation Fractions* ***cannot*** *be used for mass in* ***conditioned*** *spaces.*

| Input Data | Description: Absorbed Insolation Fractions |
|---|---|
| *FRACTION NAME* | Name of the absorbed insolation fraction. Used for identification purposes only by the user. Maximum length is 8 characters. |
| *GLAZING SURFACE NAME* | Name of the glazing surface through which the solar is being transmitted. This must be valid name defined in the Glazing Surfaces Section of input. Maximum length is 8 characters. |
| *MASS SURFACE NAME* | Name of mass surface which is absorbing the solar radiation. This must be valid name defined in the Thermal Mass Surfaces Section of input. Maximum length is 8 characters. |
| *WINTER FRACTION* | Fraction of the transmitted solar radiation absorbed by the thermal mass during the winter months. Solar not targeted to a particular mass is assumed to be absorbed by the zone air and lightweight mass. Legal values: 0.00 to 1.00. |
| *SUMMER FRACTION* | Fraction of the transmitted solar radiation absorbed by the thermal mass during the summer months. Solar not targeted to a particular mass is assumed to be absorbed by the zone air and lightweight mass. Legal values: 0.00 to 1.00. |

# Controlled Ventilation Crawlspace (CVC)

*Figure 3-11. Controlled Ventilation Crawlspace Schematic*

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**Overview**

The under floor crawlspace of a building can act as a "buffer space" for the building when crawlspace ventilation is reduced, vents are automatically controlled, and insulation under the building floor is replaced by insulation in the crawlspace walls. With these features, the soil floor of the crawlspace provides some thermal mass benefits and the placement of the insulation minimizes the influence of outdoor air on the crawlspace temperature. For compliance purposes this type of crawlspace is called a Controlled Ventilation Crawlspace (CVC).

**Example Input File**

An example input data file for a controlled ventilation crawlspace model is provided as part of MICROPAS with the file name 'MP7MP7CRAWL'.

**CVC Installation Criteria**

Refer to the Chapter 8 of the *Residential Manual* for special documentation and installation requirements for the CVC system.

## Input Data For Controlled Ventilation Crawlspaces

**Defining the Crawlspace Zone**

The Zones input data should follow the example shown in Figure 3-12. The input values CONDITIONED is 'No' and ZONE TYPE is 'CVCrawlspace'. The input values FLOOR AREA and VOLUME equal the values calculated for the crawlspace from the plans. NUMBER OF DWELLING UNITS is '0', HOUSEWRAP/AIR INFILTRATION and RADIANT BARRIER CREDITS are set to 'No'. HEATING, COOLING and DUCT SYSTEMS are set to 'None'.

The input value NATURAL VENTILATION SYSTEM NAME links a natural ventilation system to the crawlspace zone. The area of the vents are specified within the natural ventilation system. (FAN VENTILATION is set to 'None'.)

The input value THERMOSTAT TYPE, 'AutoCVCVent', specifies the opening and closing of the crawlspace vents on a seasonal basis (input values HEATING SYSTEM and COOLING SYSTEM are ignored). The automatic vents are assumed to be closed during the winter months and open during the summer months.

*Figure 3-12. CVC Zones Input Data*

```
ZONE 'CRAWLSPC'

 1> ZONE NAME ..................................... CRAWLSPC
 2> CONDITIONED (Yes, No) ......................... No
 3> ZONE TYPE ..................................... CVCrawlspace
 4> FLOOR AREA (sf) ............................... 1600
 5> VOLUME (cuft) ................................. 4800
 6> NUMBER OF DWELLING UNITS ...................... 0
CREDITS
 7> HOUSEWRAP/AIR INFILTRATION CREDIT (Yes,No,SLA) .. No
 8> RADIANT BARRIER CREDIT (Yes, No, CoolRoof) ..... No
 9> VERIFIED INSULATION QUALITY (Yes, No) ........... No
HVAC SYSTEM
 10> NUMBER OF SYSTEMS SERVING ZONE ................ 0
 11> HEATING SYSTEM NAME ........................... None
 12> COOLING SYSTEM NAME ........................... None
 13> DUCT SYSTEM NAME ............................. None
 14> NATURAL VENTILATION SYSTEM NAME ............... CRAWL.VENT
 15> FAN VENTILATION SYSTEM NAME ................... None
 16> THERMOSTAT NAME ............................... AutoCVCVent
HVAC SIZING
 17> NUMBER OF PEOPLE/UNIT (occupants/unit) ........ 0
 18> APPLIANCE GAIN/UNIT  (Btuh/unit) .............. 0
 19> INFILTRATION CLASS (Tight, Medium, Loose) ..... Medium
```

### Foundation Walls and Edge Loss

The foundation wall area (masonry or treated wood), the sill plate area and the crawlspace soil edge are the common components of the crawlspace modeled in the Opaque Surfaces Section. Solar gains for any crawlspace wall are usually ignored unless the wall is quite tall. If solar gains are ignored, the orientations of the wall can be lumped together under one opaque surface entry.

The soil is entered like a slab-on-grade in a conditioned building zone. The soil edge length (perimeter of the crawlspace) is entered as the opaque surface area and the soil edge heat loss factor (F-factor; see Joint Appendix II, Table IV.26) is entered as the surface U-factor. The mass effects of the soil floor are accounted for in the Thermal Mass Section of data.

*Figure 3-13. CVC Opaque Input Data*

```
OPAQUE SURFACES

      OPAQUE   AREA                 SOLAR OPAQUE        ZONE OR
      SURFACE  OR           PLAN    GAINS CHARAC-       OPAQUE   LOCATION/
      NAME     LENGTH TILT  AZIMUTH (Y/N) TERISTICS     NAME     COMMENTS
      ——1——— ——2——— ——3—— ——4——— ——5—— ———————6——————— ——7——— ———————8———————
 1>   CSTEM    225    Vert  n/a     No    STEM.WALL.R5  CRAWLSPC Stemwall
 2>   CPERIM   160    n/a   n/a     No    SOIL.EDGE     CRAWLSPC Perimeter
 3>   CSILL    70     Vert  n/a     No    WALL.R21      CRAWLSPC Framed Sill

OPAQUE CHARACTERISTICS

#> NUMBER OF CHARACTERISTICS (50 maximum) ..... 15
      OPAQUE        OPAQUE           CAV-  SHEATH- U-VAL  APP    APPENDIX IV
      CHARAC-       SURFACE    FRAME ITY   ING     OR     IV     LOOKUP
      TERISTIC      TYPE       TYPE  R-VAL R-VAL   F-VAL  LOOKUP NAME
      ———————1——————— ———2——— ——3—— ——4—— ——5——— ——6——— ——7——— ———————8———————
 1>   STEM.WALL.R5  Wall       None  5     0       0.157  No     NONE
 2>   SOIL.EDGE     Wall       None  0     0       0.42   No     NONE
 3>   WALL.R21      Wall       n/a   n/a   n/a     n/a    Yes    W.21.2X6.16
```

### Floor Between the House and Crawlspace

The floor between the conditioned building space and the crawlspace is modeled in the Inter-Zone Surfaces Section (see Figure 3-14). Since floor insulation is usually not installed in a CVC system, the insulation value of the carpet and pad (R-2.0) has a significant effect.

*Figure 3-14. CVC Inter-Zone Surface Input Data*

```
INTER-ZONE SURFACES

      INTERIOR           OPAQUE
      SURFACE   AREA     CHARAC-       ZONE      ZONE      LOCATION/
      NAME      (sf)     TERISTIC      SIDE #1   SIDE #2   COMMENTS
      ——1——— ——2——— ———————3——————— ———4——— ———5——— ——————————6——————————
 1>   EFLOOR    240      FLOOR.EXP     HOUSE     CRAWLSPC  Exposed Framed Floor
 2>   CFLOOR    1360     FLOOR.CVR     HOUSE     CRAWLSPC  Covered Framed Floor

OPAQUE CHARACTERISTICS

      OPAQUE        OPAQUE           CAV-  SHEATH- U-VAL  APP    APPENDIX IV
      CHARAC-       SURFACE    FRAME ITY   ING     OR     IV     LOOKUP
      TERISTIC      TYPE       TYPE  R-VAL R-VAL   F-VAL  LOOKUP NAME
      ———————1——————— ———2——— ——3—— ——4—— ——5——— ——6——— ——7——— ———————8———————
 1>   FLOOR.EXP     Floor      Wood  0     0       0.41   No     None
 2>   FLOOR.CVR     Floor      Wood  0     0       0.22   No     None
```

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**Mass Of Soil Floor**

The crawlspace soil floor is modeled like a slab-on-grade floor of a residence. The area of the soil mass should equal the crawlspace floor. The mass characteristics of the soil floor must be as follows:

Thickness = 4.0 inches
Volumetric Heat Capacity = 27 Btu/cuft-F
Conductivity = 0.60 Btu-hr/ft-F

*Figure 3-15. CVC Mass Input Data*

```
MASS SURFACES

      MASS              MASS
      SURFACE   AREA    CHARAC-       ZONE
      NAME      (sf)    TERISTICS     NAME      LOCATION/COMMENTS
      ————1———— ——2—— ———————3——————— ————4———— ———————————5———————————
 1>   SOIL      1600    CRAWL.SOIL    CRAWLSPC  Crawlspace Soil

MASS CHARACTERISTICS

      MASS                          THICK SURF- VOLUME CON-
      CHARAC-                       NESS  ACE   HEAT   DUCT-
      TERISTIC      MASS TYPE       (in)  R-VAL CAP    IVITY  UIMC
      ———————1——————— ———————2———————— ——3—— ——4—— ——5——— ——6——— ——7——
 1>   CRAWL.SOIL    InteriorHorz    4.0   0.0   27     0.60   4.6
```

**Crawlspace Ventilation**

The area of the crawlspace vent is entered in the Natural Ventilation Section of data with the input value INLET AREA PER ZONE as seen in Figure 3-16. The ventilation area entered is the crawlspace floor area on the plans times 0.75. This factor accounts for lower wind speed at crawlspace height compared to wind speeds at normal house wall height. Common crawlspace vent areas are in the range of 1.0 sf per 150 sf of crawlspace floor area. The UBC allows this value to drop as low as 0.1 sf per 150 sf with proper moisture control.

The input value HEIGHT DIFFERENCE is set to zero (0) for the crawlspace ventilation system.

*Figure 3-16. CVC Ventilation Systems Input Data*

```
NATURAL VENTILATION SYSTEMS

      NATURAL       NATURAL      INLET     HEIGHT
      VENTILATION   VENTILATION  AREA      DIFF
      SYSTEM NAME   TYPE         PER ZONE  (ft)
      ———————1——————— ———————2——————— ————3———— ———4———
 1>   CRAWL.VENT    Special      1.4       0
```

**Ducts In the Crawlspace**

The controlled ventilation crawlspace has a temperature that is more moderate compared to the fully vented crawlspace or an attic space. This results in lower HVAC duct losses (i.e., higher duct efficiencies; see Duct Systems Section in Chapter 2, Input Reference). The value 'CVCrawlspace' can be used for the input values HEATING DUCT LOCATION and COOLING DUCT LOCATION in the house zone (not in the crawlspace zone) under the following conditions:

1. All the ducts are located in the crawlspace or conditioned space (the plans must show all supply registers in the floor).
2. The foundation wall insulation of the crawlspace is at least R-5.
3. The floor between the house and crawlspace is uninsulated.

The crawlspace zone does not have to be modeled to take this higher duct efficiency into account.

*Figure 3-17. CVC Duct Systems Input Data*

```
DUCT SYSTEMS
————————————
 #> NUMBER OF DUCTS (25 maximum) ..................... 15
      DUCT          DUCT     HEATING       COOLING                VERIF   VERIF   VERIF
      SYSTEM        INSUL    DUCT          DUCT          VERIF    SURFACE BURIED
      NAME          R-VALUE  LOCATION      LOCATION      LEAKAGE  AREA    DUCT
      ———————1——————— ———2——— ———————3——————— ———————4——————— ———5——— ———6——— ———7———
 12>  CRAWL.R4.2     4.2      Crawlspace    Crawlspace    No       No      No
```

# Sunspaces

**Overview**

An attached sunspace with the proper design and operation can provide supplemental space heating to the building, reducing conventional space heating energy use. A sunspace is normally an unconditioned space attached to the building that has a large amount of south-facing glass for winter heating and, conversely, a large amount of operable glass or vents for summer venting.

**Example Input File**

An example input data file for a sunspace model is provided as part of MICROPAS with the file name 'MP7MP7SUN'.

## Input Data For Sunspaces

**Defining the Sunspace Zone**

The ZONE Input data for a sunspace should follow the example shown in Figure 3-18. To specify a sunspace, the input values CONDITIONED, ZONE TYPE, NUMBER OF DWELLING UNITS and THERMOSTAT TYPE must be set to 'No', 'Sunspace', '0' and 'SunspaceStat', respectively. The input values FLOOR AREA and VOLUME are set according to the dimensions of the sunspace as shown on the plans.

*Figure 3-18. Sunspace Zone Input Data*

```
ZONE 'SUNSPACE'
 1> ZONE NAME ..................................... SUNSPACE
 2> CONDITIONED (Yes, No) ......................... No
 3> ZONE TYPE ..................................... Sunspace
 4> FLOOR AREA (sf) ............................... 200
 5> VOLUME (cuft) ................................. 2000
 6> NUMBER OF DWELLING UNITS ...................... 0
CREDITS
 7> HOUSEWRAP/VERIFIED AIR LEAKAGE (Yes,No,SLA) ..... No
 8> RADIANT BARRIER (Yes, No, CoolRoof) ............. No
 9> VERIFIED INSULATION QUALITY (Yes, No) ........... No
HVAC SYSTEM
 10> NUMBER OF SYSTEMS SERVING ZONE ................ 1
 11> HEATING SYSTEM NAME ........................... None
 12> COOLING SYSTEM NAME ........................... None
 13> DUCT SYSTEM NAME ............................. None
 14> NATURAL VENTILATION SYSTEM NAME ............... SUNSPACE
 15> FAN VENTILATION SYSTEM NAME ................... None
 16> THERMOSTAT NAME ............................... SunspaceStat
HVAC SIZING
 17> NUMBER OF PEOPLE/UNIT (occupants/unit) ......... 4
 18> APPLIANCE GAIN/UNIT  (Btuh/unit) ............... 1200
 19> INFILTRATION CLASS (Tight, Medium, Loose) ...... Medium
```

**Opaque, Glazing and Mass Surfaces**

The walls, ceilings, doors and floors between the sunspace and the outdoors are entered in the same way as the surfaces for the conditioned building space with the following exception: The input value ZONE NAME is set to 'SUNSPACE' or to the zone name that was defined as the sunspace in the ZONE Section of input. Figure 3-19 provides examples of the sunspace surfaces.

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*Figure 3-19. Sunspace Surfaces to Exterior--Example Input Data*

```
OPAQUE SURFACES

      OPAQUE   AREA                  SOLAR OPAQUE        ZONE OR
      SURFACE  OR           PLAN    GAINS CHARAC-       OPAQUE   LOCATION/
      NAME     LENGTH TILT  AZIMUTH (Y/N) TERISTICS     NAME     COMMENTS
      ---1---- --2--- --3-- ---4--- --5-- -------6------- ---7---- --------8--------
 1>   SLWALL   80     Vert  Left    Yes   WALL.R13      SUNSPACE
 2>   SRWALL   80     Vert  Right   Yes   WALL.R13      SUNSPACE

GLAZING SURFACES

      GLAZING                       GLAZING       OVERHANG  INT/EXT   ZONE OR
      SURFACE  AREA         PLAN    CHARAC-       SIDE FIN  SHADE     OPAQUE
      NAME     (sf)   TILT  AZIMUTH TERISTICS     NAME      NAME      NAME
      ---1---- --2--- -3-- ---4--- -------5------- ----6---- ----7---- ---8----
 1>   SBGLASS1 140    Vert  Back    MT.OP         None      STANDARD  SUNSPACE
 2>   SBGLASS2 200    18.5  Back    MT.SKY        None      None      SUNSPACE

MASS SURFACES

      MASS              MASS
      SURFACE   AREA    CHARAC-       ZONE
      NAME      (sf)    TERISTICS     NAME      LOCATION/COMMENTS
      ----1---- ---2--- -------3------ ----4---- -------------5-------------
 1>   SS.SLAB   200     SLAB.EXP      SUNSPACE  Exposed
```

**Absorbed Solar**

Solar radiation, which is transmitted through the sunspace glazing, can be directed to masses in the sunspace through the use of Absorbed Insolation Fractions. Figure 3-10 and the associated discussion (found earlier in this chapter) describe the use of absorbed insolation fractions within unconditioned zones. Note that absorbed insolation fractions are defined by linking glazing surfaces to masses.

**Inter-Zone Surfaces**

Walls, doors and glazing surfaces between the house and sunspace are entered in the INTER-ZONE SURFACES Section of input. Figure 3-20 provides examples of the sunspace surfaces.

**Ventilation Between House and Sunspace**

An inter-zone vent system must be set up to model the ventilation between the conditioned zone and the sunspace, as illustrated in Figure 3-21. The input value VENTILATION INLET AREA PER ZONE is set to 40% of the total operable area of glazing, doors and vents between the sunspace and conditioned zone.

*Figure 3-20. Sunspace Inter-Zone Surfaces Input Data*

```
INTER-ZONE SURFACES

      INTERIOR          OPAQUE
      SURFACE   AREA    CHARAC-       ZONE      ZONE      LOCATION/
      NAME      (sf)    TERISTIC      SIDE #1   SIDE #2   COMMENTS
      ----1---- ---2--- -------3------ ----4---- ----5---- ----------6----------
 1>   SSWALL    160     WALL.R13      HOUSE     SUNSPACE
 2>   SSGLASS   160     SS.GLASS      HOUSE     SUNSPACE
```

*Figure 3-21. Sunspace Inter-Zone Vent Input Data*

```
INTER-ZONE VENTILATION SYSTEMS

                VENT           CONTROL    SECONDARY
                SYSTEM         ZONE       ZONE        LOCATION/
      NAME      NAME           NAME       NAME        COMMENTS
      ———1——— ———————2——————— ———3——— ———4——— ——————————5——————————
 1>   SSVENT    SUNHOUSE       HOUSE      SUNSPACE

NATURAL VENTILATION SYSTEMS

      NATURAL       NATURAL       INLET     HEIGHT
      VENTILATION   VENTILATION   AREA      DIFF
      SYSTEM NAME   TYPE          PER ZONE  (ft)
      ———————1——————— ———————2——————— ———3——— ———4———
 1>   SUNHOUSE      Special       10.0      2.0
```

**Sunspace Ventilation To Outdoors**

Sunspace ventilation to the outdoors is critical for preventing sunspace overheating during all except the coldest months of the year. The input value INLET AREA PER ZONE is set to 40% of the actual operable area of sunspace glazing, doors and vents between the sunspace and the exterior. The input value HEIGHT DIFFERENCE is set to the actual height difference of the upper and lower operable ventilation areas of the sunspace. The minimum value used for the sunspace HEIGHT DIFFERENCE is 2.0 ft.

*Figure 3-22. Sunspace Ventilation to the Outdoors*

```
NATURAL VENTILATION SYSTEMS

      NATURAL       NATURAL       INLET     HEIGHT
      VENTILATION   VENTILATION   AREA      DIFF
      SYSTEM NAME   TYPE          PER ZONE  (ft)
      ———————1——————— ———————2——————— ———3——— ———4———
 1>   SUNSPACE      Special       25.0      10.0
```

# Adding to Appendix IV Lookup Tables

**Overview**

U-factors and F-factors determine the conductive heat transfer of opaque surfaces. The Form 3R is replaced by tables of U-factors developed by the CEC and published in Joint Appendix IV of the *Building Energy Efficiency Standards*. The multiple tables of Appendix IV cover most known construction types.

MICROPAS includes the most often used constructions in the program (see Chapter 2, OPAQUE CHARACTERISTICS). However, there are hundreds of other potential assemblies that a user might need. Users may add construction assembly values from Joint Appendix IV as needed.

This section of ADVANCED TOPICS discusses the process for adding values from Appendix IV into your MICROPAS software.

☞ ***NOTE – APPENDIX IV Operations:*** *MICROPAS APPENDIX IV values are added outside the Edit Input Menu and thus all assemblies are available for every Building Input File that you create.*

**Appendix IV Operations Menu**

To add Construction U-factors, select the OTHER OPERATIONS option from the MAIN MENU. Then select the APPENDIX IV operations menu. Figure 3-23 shows the menu that is displayed.

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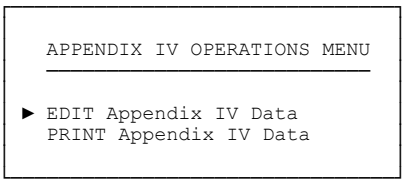
*Figure 3-23.Appendix IV Operations Menu*




**Editing Appendix IV data**

To edit the Appendix IV library, select the *EDIT Appendix IV Data* option.

**Printing Appendix IV data**

The *Print Appendix IV Data* option will print **all** of the Appendix IV data within the Appendix IV library either to the screen or to the printer.

It is not necessary to print Appendix IV data as part of a building department submittal. The CF-1R contains enough information for the plan checker to verify the values used for compliance.

**Adding Construction Types**

Joint Appendix IV can be obtained from the California Energy Commission's web site (www.energy.ca.gov/Title24). See

Figure 3-24 for an excerpt of that document.

The values in the Appendix IV tables contain everything needed to add constructions to the Appendix IV library.

*Figure 3-24. Portion of Appendix IV, Table IV.2 Rafter Roofs*



*Table IV.2 – U-factors of Wood Framed Rafter Roofs*

| Rafter Spacing | R-value of Cavity Insulation | Nominal Framing Size | | Rated R-value of Continuous Insulation[2] None | R-2 | R-4 | R-6 | R-7 | R-8 | R-10 | R-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A | B | C | D | E | F | G | H |
| 16 in. OC | None | Any | 1 | 0.297 | 0.184 | 0.134 | 0.105 | 0.095 | 0.087 | 0.074 | 0.057 |
| | R-11 | 2x6 | 2 | 0.076 | 0.066 | 0.058 | 0.052 | 0.049 | 0.047 | 0.043 | 0.037 |
| | R-13 | 2x6 | 3 | 0.069 | 0.060 | 0.053 | 0.048 | 0.046 | 0.044 | 0.040 | 0.034 |
| | R-15 | 2x6 | 4 | 0.062 | 0.055 | 0.049 | 0.045 | 0.043 | 0.041 | 0.038 | 0.033 |
| | R-19 | 2x8 | 5 | 0.051 | 0.046 | 0.042 | 0.038 | 0.037 | 0.036 | 0.033 | 0.029 |
| | R-21 | 2x8 | 6 | 0.048 | 0.043 | 0.039 | 0.036 | 0.035 | 0.034 | 0.031 | 0.028 |
| | R-22 | 2x10 | 7 | 0.044 | 0.041 | 0.037 | 0.035 | 0.033 | 0.032 | 0.030 | 0.027 |
| | R-25 | 2x10 | 8 | 0.041 | 0.037 | 0.034 | 0.032 | 0.031 | 0.030 | 0.028 | 0.025 |
| | R-30 [1] | 2x10 | 9 | 0.036 | 0.033 | 0.031 | 0.029 | 0.028 | 0.027 | 0.026 | 0.023 |
| | R-30 | 2x12 | 10 | 0.035 | 0.032 | 0.030 | 0.028 | 0.027 | 0.027 | 0.025 | 0.023 |
| | R-38[1] | 2x12 | 11 | 0.029 | 0.027 | 0.026 | 0.024 | 0.024 | 0.023 | 0.022 | 0.020 |
| | R-38 | 2x14 | 12 | 0.028 | 0.027 | 0.025 | 0.024 | 0.023 | 0.023 | 0.022 | 0.020 |
| | Foamed Plastic or Cellulose Insulation[1] | 2x4 | 13 | 0.074 | 0.064 | 0.056 | 0.050 | 0.047 | 0.045 | 0.041 | 0.035 |
| | | 2x6 | 14 | 0.052 | 0.046 | 0.042 | 0.038 | 0.037 | 0.035 | 0.033 | 0.029 |
| | | 2x8 | 15 | 0.041 | 0.037 | 0.034 | 0.032 | 0.031 | 0.030 | 0.028 | 0.025 |
| | | 2x10 | 16 | 0.033 | 0.031 | 0.029 | 0.027 | 0.026 | 0.025 | 0.024 | 0.022 |
| | | 2x12 | 17 | 0.028 | 0.026 | 0.025 | 0.023 | 0.023 | 0.022 | 0.021 | 0.019 |
| 24 in. OC | None | Any | 18 | 0.237 | 0.160 | 0.121 | 0.097 | 0.089 | 0.081 | 0.070 | 0.055 |
| | R-11 | 2x6 | 19 | 0.075 | 0.065 | 0.057 | 0.051 | 0.049 | 0.046 | 0.042 | 0.036 |
| | R-13 | 2x6 | 20 | 0.067 | 0.058 | 0.052 | 0.047 | 0.045 | 0.043 | 0.040 | 0.034 |

# Editing Appendix IV

*Figure 3-25. Edit Menu*

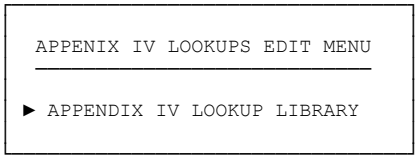



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*Figure 3-26. Appendix IV Library*

```
APPENDIX IV LOOKUP LIBRARY
──────────────────────────

 #> NUMBER OF LOOKUPS (200 maximum) ................. 29

LOOKUP 'W.13.2X4.16.R4'

 1> APPENDIX IV LOOKUP NAME ......................... W.13.2X4.16.R4
 2> DESCRIPTION ..................................... Wall R13+R4 2x4 16oc
 3> SURFACE TYPE .................................... Wall
 4> FRAME TYPE (Wood,Metal,Other,None) .............. Wood
 5> FRAME SIZE (2X4,2X6,etc) ....................... 2X4
 6> FRAME SPACING (inches on center) ................ 16
 7> CAVITY R-VALUE (hr-sf-F/Btu) .................... 13
 8> SHEATHING R-VALUE (hr-sf-F/Btu) ................. 4
 9> U-VALUE OR F-VALUE (Btu/hr-F per sf or ft) ..... 0.068
 10> APPENDIX IV TABLE (IV.1 - IV.28) ............... IV.9
 11> APPENDIX IV CELL (A1,C3,E2O,etc) ............... C3
```

| Input Data | Description: Appendix IV Lookup Library |
|---|---|
| *LOOKUP NAME* | Name of construction. This name is used to link the characteristics of the material to the construction assembly. Maximum length is 14 characters. |
| *DESCRIPTION* | Description of the assembly. This description does not appear on any of the documentation. Maximum length is 25 characters. |
| *SURFACE TYPE* | Keyword to identify if the surface is a wall, roof, door, slab edge (the same surface types that are available in opaque characteristics). |
| *FRAME TYPE* | Assembly frame type. Legal values: 'Wood', 'None', 'Metal', or 'Other'. |
| *FRAME SIZE* | Frame size, if applicable. For example 2x4, 2x8. Leval values: 2x4, 2x6, 2x8, 2x10, 2x12, or n/a. |
| *FRAME SPACING* | The "on-center" space of framing. For example, 24 or 16 inches. Legal value: integer. |
| *CAVITY R-VALUE* | The rated R-value of cavity insulation. Legal value: integer. |
| *SHEATHING R-VALUE* | The rated R-value of sheathing or rigid insulation. Legal value: integer |
| *U-VALUE OR F-FALUE* | The U-factor or F-factor from Appendix IV. |
| *APPENDIX IV TABLE* | The Appendix IV Table number. For example, wood framed walls are in Table IV.9. |
| *APPENDIX IV CELL* | The column letter and row number in which the appropriate U-factor or F-factor is found. For example, a 2x6, 16" o.c. wood framed wall with R-19 cavity insulation and R-6 rigid insulation is found in cell D5 |

**Using Appendix IV Lookup values**

To include an assembly in a building under analysis, the Appendix IV lookup name (defined here in the library) must be entered as the APPENDIC IV LOOKUP NAME within the OPAQUE CHARACTERISTICS Input Section of the building file (see Figure 3-27 for an example).

*Figure 3-27. Example Using Appendix IV Within OPAQUE CHARACTERISTICS Section*

```
#> NUMBER OF CHARACTERISTICS (50 maximum) .......... 13

      OPAQUE          OPAQUE            CAV-   SHEATH-  U-VAL   APP     APPENDIX IV
      CHARAC-         SURFACE    FRAME  ITY    ING      OR      IV      LOOKUP
      TERISTIC        TYPE       TYPE   R-VAL  R-VAL    F-VAL   LOOKUP  NAME
      ———1———— ———2——— —3— —4— —5— —6— —7— ———8————
 1>   WALL.R13        Wall       n/a    n/a    n/a      n/a     Yes     W.13.2X4.16
 2>   WALL.R15        Wall       n/a    n/a    n/a      n/a     Yes     W.15.2X4.16
 3>   WALL.R19        Wall       n/a    n/a    n/a      n/a     Yes     W.19.2X6.16
 4>   WALL.R21        Wall       n/a    n/a    n/a      n/a     Yes     W.21.2X6.16
 5>   ROOF.R19.16     Roof       n/a    n/a    n/a      n/a     Yes     R.19.16
 6>   ROOF.R30.16     Roof       n/a    n/a    n/a      n/a     Yes     R.30.16
```

# Exterior Mass

**Overview**

Exterior thermal mass elements of a building, such as concrete block walls, log walls and suspended slab floors, have two components that affect building performance:

1. Heat transfer (which may be greater than an insulated wall)
2. Thermal mass, which may offset or surpass the heat transfer effects of the exterior surface

The exterior mass modeling capabilities of MICROPAS allow the user to correctly account for both of these components. Note that it is important to model *both* of the components listed above, as the building may be unfairly penalized or rewarded if not modeled correctly.

Figure 3-28 is an illustration of the input values for an exterior mass wall. Figure 3-29 and Figure 3-30 provide typical input data for the Mass and Opaque input data.

**Insulated Mass Walls and Floors**

Mass walls may contain insulation on the exterior surface, the interior surface, both surfaces or may have insulation between mass sections (e.g. foam-filled concrete block). Depending on the R-value of the insulation and the surface on which it is applied, the mass may be modeled as interior or exterior mass.

Mass walls that are insulated on the **exterior** to R-11 or more are not exterior mass and the mass need not be coupled to an opaque surface. In this case, the mass surface is modeled as interior mass.

When insulation is applied to the **interior** surface, the feature is modeled as exterior mass, however, the thermal mass benefits are greatly reduced.

When insulation is applied to **both** surfaces or the **interior** (e.g. foam-filled concrete block), the benefits gained from modeling the thermal mass will vary, depending on the R-value of the insulation applied.

☞ ***NOTE –Log Homes:*** *Solid wood walls must be modeled as exterior mass.*

**Example Input File**

An example input data file for a house with exterior concrete block walls is provided as part of MICROPAS with the file name 'MP7XMASS'.

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*Figure 3-28. Schematic of Input Values for an Exterior Mass Wall*

# Mass Input Data

**Mass Construction**

Enter the mass material properties and the thickness of the exterior mass in the MASS CHARACTERISTICS Section. Unit Interior Mass Capacity (UIMC) values can be found in Chapter 2, Tables 2-12 and 2-13. If the mass is a wall, set the type as 'ExteriorVert'. Set type to 'ExteriorHorz' for a floor. The thickness of an interior mass wall is cut in half, with both sides of the surface modeled.

**Locating the Mass**

The mass is linked to the building zone with a thermal mass surface entry as seen in Figure 3-29.

**Mass Area**

The area of the exterior mass surface is entered twice. Once, as an input in the MASS SURFACES Section, and again as one or more entries in the OPAQUE SURFACES Section. The mass surface area and the total opaque surface area linked to the exterior mass must be equal. Glazing area must be subtracted and the net area of opaque and mass surfaces is entered.

**Interior Insulation**

The insulation level on the interior surface of the mass, if any, is specified with the input value SURFACE R-VALUE, under the MASS CHARACTERISTICS Section. Do not include interior air films.

*Figure 3-29. Thermal Mass Data for Exterior Mass Walls*

```
MASS SURFACES

      MASS                 MASS
      SURFACE    AREA      CHARAC-        ZONE
      NAME       (sf)      TERISTICS      NAME       LOCATION/COMMENTS
      ———1——— ———2——— ———————3——————— ————4———— ———————————5———————————
 1>   MASSWALL   948       MASSMATERIAL   HOUSE      Exterior Mass Wall

MASS CHARACTERISTICS

      MASS                             THICK SURF- VOLUME CON-
      CHARAC-                          NESS  ACE   HEAT   DUCT-
      TERISTIC       MASS TYPE         (in)  R-VAL CAP    IVITY  UIMC
      ———————1——————— ———————2——————— ——3—— ——4—— ——5——— ——6——— ——7——
 1>   MASSMATERIAL   ExteriorVert      8.0   0.0   28     0.98   1.8
```

# Opaque Input Data

**Opaque Surfaces**

The orientation, solar gains and area of the exterior mass are specified with one or more OPAQUE SURFACE entries (see Figure 3-30). MICROPAS ignores the opaque surface U-value, therefore the U-VALUE input is set to 'n/a' as shown in Figure 3-30. These surfaces are linked to the exterior mass surface by entering the specific MASS SURFACE NAME (found in the MASS SURFACES Section) as the input value ZONE OR OPAQUE NAME in the OPAQUE SURFACES Section.

☞ ***NOTE - Net Wall Area****: Any exterior mass surface area must be calculated and entered into MICROPAS as net wall areas in the OPAQUE SURFACES Section. Gross wall areas, with windows and doors linked to them, will result in a MICROPAS error.*

*Figure 3-30. Opaque Surface Data for Exterior Mass Walls*

OPAQUE SURFACES

| | OPAQUE SURFACE NAME | AREA OR LENGTH | TILT | PLAN AZIMUTH | SOLAR GAINS (Y/N) | OPAQUE CHARACTERISTICS | ZONE OR OPAQUE NAME | LOCATION/ COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1> | FWALL | 204 | Vert | Front | Yes | OUTSIDEMASS | MASSWALL | |
| 2> | LWALL | 264 | Vert | Left | Yes | OUTSIDEMASS | MASSWALL | |
| 3> | BWALL | 192 | Vert | Back | Yes | OUTSIDEMASS | MASSWALL | |
| 4> | RWALL | 288 | Vert | Right | Yes | OUTSIDEMASS | MASSWALL | |

OPAQUE CHARACTERISTICS

| | OPAQUE CHARACTERISTIC | OPAQUE SURFACE TYPE | FRAME TYPE | CAVITY R-VAL | SHEATHING R-VAL | U-VAL OR F-VAL | APP IV LOOKUP | APPENDIX IV LOOKUP NAME |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1> | OUTSIDEMASS | Wall | None | 2 | n/a | n/a | No | None |

**Example**

The example input data shown in Figure 3-29 and Figure 3-30 represent a house that has 948 sf of 8 inch filled concrete block wall area instead of the typical wood framed exterior walls. The wall is located on each of the four building facades. The wall is covered with gypsum board on the interior (R-2).

# Insulated Mass Walls

**Outside Surface Insulated**

If mass walls are insulated on the exterior of the mass surface, model the R-value as CAVITY R-VALUE in the OPAQUE CHARACTERISTICS.

*Figure 3-31. Mass Wall Insulated on the Exterior*

OPAQUE SURFACES

| | OPAQUE SURFACE NAME | AREA OR LENGTH | TILT | PLAN AZIMUTH | SOLAR GAINS (Y/N) | OPAQUE CHARACTERISTICS | ZONE OR OPAQUE NAME | LOCATION/ COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1> | FWALL | 204 | Vert | Front | Yes | OUTSIDEMASS | MASSWALL | |

OPAQUE CHARACTERISTICS

| | OPAQUE CHARACTERISTIC | OPAQUE SURFACE TYPE | FRAME TYPE | CAVITY R-VAL | SHEATHING R-VAL | U-VAL OR F-VAL | APP IV LOOKUP | APPENDIX IV LOOKUP NAME |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1> | OUTSIDEMASS | Wall | None | 5.0 | n/a | n/a | No | None |

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**Inside Surface Insulated**

When mass walls are insulated on the inside surface of the mass, the R-value of the insulation is shown in the input SURFACE R-VALUE of the MASS CHARACTERISTICS.

*Figure 3-32. Mass Wall Insulated on the Interior*

```
MASS SURFACES

      MASS                MASS
      SURFACE    AREA     CHARAC-        ZONE
      NAME       (sf)     TERISTICS      NAME       LOCATION/COMMENTS
      ———1——— ——2—— ———3——— ——4——— ————————5————————
 1>   MASSWALL   948      MASSMATERIAL   HOUSE      Exterior Mass Wall

MASS CHARACTERISTICS

      MASS                            THICK SURF- VOLUME CON-
      CHARAC-                         NESS  ACE   HEAT   DUCT-
      TERISTIC       MASS TYPE        (in)  R-VAL CAP    IVITY  UIMC
      ———1——— ———2——— ——3—— ——4—— ——5—— ——6—— ——7——
 1>   MASSMATERIAL ExteriorVert       8.0   13.0   28     0.98   1.8
```

# Below Grade Surfaces

**Overview**

Walls of a conditioned basement (below-grade walls) are a type of exterior mass surface that is modeled as an OPAQUE SURFACE as well as MASS. The OPAQUE SURFACE NAME and the MASS SURFACE NAME are linked. The Net Area method must be used for opaque and mass areas (subtract doors and glazing). A sample file, MP7BSMT, illustrates the concepts clarified here. Figure 3-33 provides a sample of opaque surface inputs, and Figure 3-34 provides a sample of mass surface inputs.

## Opaque

**Overview**

The OPAQUE SURFACE TYPE varies with the depth of the wall. Valid types are: 'WallBaseA' (0-1.99 feet below grade), 'WallBaseB' (2.0-5.99 feet below grade) and 'WallBaseC' (more than 6 feet below grade). For an 8-foot high wall that is completely below grade, the top 1.99 feet are modeled as WallBaseA, the middle portion is modeled as WallBaseB, and the bottom 2 feet are modeled as WallBaseC.

The basement floor is also a type of exterior mass surface modeled as both a MASS and an OPAQUE SURFACE (surface type 'FloorBase'); however, there are no edge losses.

**Linking Opaque and Mass Surfaces**

Link the mass and opaque surfaces by entering the MASS SURFACE NAME in the field ZONE OR OPAQUE NAME.

**Outside Surface Insulated**

If mass walls are insulated on the outside of the mass surface, the R-value of the insulation is shown in the input CAVITY R-VALUE in OPAQUE CHARACTERISTICS. The example shows a below grade wall with the first few inches having R-7 rigid insulation on the exterior surface.

*Figure 3-33. Opaque Surface Data for a Basement*

OPAQUE SURFACES

| | OPAQUE SURFACE NAME (1) | AREA OR LENGTH (2) | TILT (3) | PLAN AZIMUTH (4) | SOLAR GAINS (Y/N) (5) | OPAQUE CHARACTERISTICS (6) | ZONE OR OPAQUE NAME (7) | LOCATION/ COMMENTS (8) |
|---|---|---|---|---|---|---|---|---|
| 1> | SHALLOW | 420 | Vert | n/a | No | BSHALLOW | BSHAL | |
| 2> | MEDIUM | 420 | Vert | n/a | No | BMEDIUM | BMED | |
| 3> | DEEP | 420 | Vert | n/a | No | BDEEP | BDEEP | |
| 4> | FWALL | 320 | Vert | Front | Yes | WALL.R19 | HOUSE | |
| 5> | LWALL | 288 | Vert | Left | Yes | WALL.R19 | HOUSE | |
| 6> | BWALL | 320 | Vert | Back | Yes | WALL.R19 | HOUSE | |
| 7> | RWALL | 288 | Vert | Right | Yes | WALL.R19 | HOUSE | |
| 8> | BFLOOR | 1200 | n/a | n/a | No | BASEFLOOR | BSLAB | |

OPAQUE CHARACTERISTICS

| | OPAQUE CHARACTERISTIC (1) | OPAQUE SURFACE TYPE (2) | FRAME TYPE (3) | CAVITY R-VAL (4) | SHEATHING R-VAL (5) | U-VAL OR F-VAL (6) | APP IV LOOKUP (7) | APPENDIX IV LOOKUP NAME (8) |
|---|---|---|---|---|---|---|---|---|
| 1> | BSHALLOW | WallBaseA | None | 7.0 | n/a | n/a | No | None |
| 2> | BMEDIUM | WallBaseB | None | n/a | n/a | n/a | No | None |
| 3> | BDEEP | WallBaseC | None | n/a | n/a | n/a | No | None |
| 4> | BASEFLOOR | FloorBase | None | n/a | n/a | n/a | No | None |

# Mass

**Overview**

For below grade surfaces that are covered (e.g. by cabinets or gyp-board), the covering R-value is entered as the SURFACE R-VALUE. Walls will have the MASS TYPE set to 'ExteriorVert' and floors to 'ExteriorHorz'. See Chapter 2 (Tables 2-12 and 2-13) for the correct Unit Interior Mass Capacity (UIMC) for the surface being modeled.

The basement floor is modeled using the same guidelines for covered and exposed surfaces as for any other slab on grade surface (see Table 2-10 in Chapter 2).

If a significant amount of mass wall protrudes above the soil line, that area is counted as exterior mass (significant means the height of the exposed mass wall would be greater than the height of a typical slab-floor edge).

☞ ***NOTE – Mass Type BelowGrade:*** *The modeling assumptions associated with the keyword 'BelowGrade' do not reflect current assumptions for below grade surfaces. This keyword should not be used.*

**Inside Surface Insulated**

If mass walls are insulated on the inside surface, the R-value of the insulation is shown in the input SURFACE R-VALUE of the MASS CHARACTERISTICS. The example shows the below grade wall with an effective insulation value of R-10.8 (including framing, insulation and gyp-board).

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*Figure 3-34. Thermal Mass Data for a Basement*

```
MASS SURFACES

      MASS                MASS
      SURFACE   AREA      CHARAC-        ZONE
      NAME      (sf)      TERISTICS      NAME       LOCATION/COMMENTS
      ———1——— ———2——— ———————3——————— ———4——— ———————————5———————————
 1>   BSHAL     420       BWALL          HOUSE      Shallow Basement
 2>   BMED      420       BWALL          HOUSE      Medium Basement
 3>   BDEEP     420       BWALL          HOUSE      Deep Basement
 4>   BSLAB     1200      BASE.FLR       HOUSE      Basement Floor

MASS CHARACTERISTICS

      MASS                              THICK SURF- VOLUME CON-
      CHARAC-                           NESS  ACE   HEAT   DUCT-
      TERISTIC      MASS TYPE           (in)  R-VAL CAP    IVITY  UIMC
      ———————1——————— ———————2——————— ——3—— ——4—— ——5——— ——6——— ——7——
 1>   BWALL         ExteriorVert        8.0   10.8  15.7   0.44   1.8
 2>   BASE.FLR      ExteriorHorz        3.5    2.0  28     0.98   1.8
```

# Gas Absorption Cooling

The California Energy Commission (CEC) has approved a calculation method for gas absorption cooling systems..Unlike typical residential electric air conditioners which are rated with an SEER value for cooling, the ratings for gas absorption cooling systems are the COP, the Capacity (Btu/hr) and the parasitic electric energy (W) rated at 95 degrees F. are the COP.

# Cooling Systems

*Figure 3-35. Gas Heat Pump Cooling Systems*

```
#> NUMBER OF COOLING SYSTEMS (25 maximum) .......... 1
      COOLING       COOLING                          VERIF  VERIF       VERIF
      SYSTEM        SYSTEM                    VERIF  REFRIG AIR   VERIF  COOL
      NAME          TYPE      SEER            EER    OR TXV FLOW  FAN    CAP
      ———————1——————— ———2——— —3——           ——4—— ——5——— ——6—— ——7—— ——8——
 1>   HPGASCOOL     GasAsorp  2.9/40000/150     No     No     No    No     No
```

**Input Data** — **Description: Cooling Systems**

*COOLING SYSTEM NAME* — Name of the cooling system. This name is used to link the cooling system to the zone data. Maximum length is 12 characters.

*COOLING SYSTEM DESCRIPTION* — Type of cooling system. Keyword to specify a gas absorption cooling system is 'GasAbsorption'.

*SEASONAL EER* — Instead of an SEER, the model requires that the COP, Capacity and electrical energy be entered in the SEER field separated by a slash (/).. For example, if COP is 2.9, the capacity is 40000 Btu/hr and the parasitic electrical energy is 100 W, the input is '2.9/40000/100'.

# Chapter 4: REPORT DESCRIPTIONS


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# Overview

This chapter describes the compliance reports generated by MICROPAS. The primary report for the performance compliance method is:

- CF-1R Certificate of Compliance – Residential Computer Method

The supporting documentation consist of the following reports:

- MF-1R Mandatory Measures Checklist
- HVAC Sizing Calculation Report (an optional report as the CF-1R now includes a summary)
- Additional non-MICROPAS documentation or compliance forms such as manufacturers literature or test data may be appropriate for special building features.

The CF-1R Report is described here in great depth. Refer to the *Residential Manual* for further information on the MF-1R form.

**What to Submit**

The next section is devoted to discussing the various reports required for submittal to the building department.

**Plan Checking MICROPAS Compliance Submittals**

he energy compliance plan check should include detailed review of the CF-1R Report for the Computer Compliance method to insure the input values used accurately represent the building plans being submitted. Chapter 2, Input Reference, describes the MICROPAS input data in great detail and should be the primary reference for plan checking MICROPAS submittals. Except for some data conversions required by MICROPAS to meet the CEC reporting format, the data listed on these reports is the same as the data entered by the user.

# What To Submit

The energy compliance submittal must demonstrate that the Proposed Design complies with energy requirements and must clearly indicate to the building official the proposed energy features of the building that were considered in the compliance analysis. Compliance is demonstrated on one of two forms. For new buildings, the Energy Use Summary on the CF-1R will show a positive compliance margin.

**Example Reports**

This chapter provides an example of each report

## Computer Performance Submittals

A list of the submittal requirements for the typical Computer Performance compliance analysis using MICROPAS is shown in Table 4-1. In special cases, additional documentation is required, as shown in Table 4-2.

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*Table 4-1. Typical Computer Performance Submittal Requirements*

| Documentation | Comment |
|---|---|
| CF-1R Report | Must be signed by the documentation author and the owner or designer, and must be on the plans. |
| MF-1R | Completed mandatory measures checklist as found in the *Residential Manual*. |

*Table 4-2. Special Submittal Requirements*

| Documentation | Comment |
|---|---|
| HVAC Sizing Report | The CF-1R now includes an HVAC sizing summary, so this report is generally not needed. In the event that more detail is desired, only HVAC Sizing "Summary" pages are suggested. The HVAC Sizing "Detailed" provides more information than is normally needed for submittals or equipment selection. |
| Other calculations or compliance forms | In special cases, hand calculations may be required to establish input values or the final compliance energy use. These cases are discussed in Chapter 3, Advanced Topics. |
| Product literature | Manufacturer's product literature is needed to document any special input values used such as R-values of insulation products, glazing U-factors and solar heat gain coefficients, etc. |

# Energy Specifications On The Plans

Upon completion of the MICROPAS compliance analysis, the energy related specifications on the building plans need to be updated to include the items listed in Table 4-3.

*Table 4-3. Energy Specifications Required on Plans*

| Documentation | Comment |
|---|---|
| CF-1R | A signed CF-1R must be on the plans so that the field inspector and the subsequent owners know the energy specifications of the building. |
| mandatory features | Although the MF-1R is not required to be on the plans, notes on the plans must establish compliance with the mandatory features. |
| other specifications | All energy features modeled must be shown on the building plans (i.e., noted on the floor plans, on sections, in window schedules, etc., as appropriate). |

# Other Documentation

**Signature Requirements**

The CF-1R must be signed by the building designer or building owner and the preparer of the compliance documentation, also known as the documentation author. (There are no licensing requirements for the documentation author to prepare these documents.)

**HVAC Sizing**

The Mandatory Measures in the Standards require determining design heat loss rate and design heat gain rate by an acceptable method. MICROPAS performs approved load calculations with its HVAC Sizing option. These sizing calculations may be supplied to the person responsible for equipment selection, such as the mechanical contractor or installer. That individual is required to provide Form CF-6R, an Installation Certificate, which must be posted at the building site or made available to the building inspector prior to final inspection. The CF-6R is not required for permit submittal. It is intended to insure installation of equipment that meets the efficiency requirements of the compliance documentation. It may also serve to demonstrate compliance with the UBC requirement that the heating system be capable of maintaining 70 degrees at a height three above the floor throughout the conditioned space of the building. See the *Residential Manual* for more information.

**Communicating With Clients**

If the compliance work is performed on a consulting basis, it is extremely important for the consultant to convey to his/her client (the designer, owner or builder), in a clear and concise manner, any energy features required to meet the standards. The easiest way to do this is with a cover letter or by discussing the CF-1R Report with the client. Clients should be informed that the installing contractor on many building components must complete and sign the CF-6R installation certificate.

Communication is particularly important if measures are modeled that will require a HERS rater to perform diagnostic testing or verification. If HERS verified features are specified, then a CF-4R form must be completed by the HERS rater prior to final inspection.

To find a HERS rater in your area, visit the website of one of the two HERS providers: www.calcerts.com or www.cheers.org.

**Compliance Comments**

MICROPAS provides a means to annotate the compliance documentation with information that clarifies the analysis for all parties involved. Compliance notes can be made in the Location/Comment fields and the Remarks section of the input data. These notes appear following special features on the CF-1R Reports.

# CF-1R Certificate of Compliance – Residential Computer Method

The *CF-1R Certificate of Compliance – Residential Computer Method* provides a detailed listing of the values assumed for the MICROPAS input and provides an energy use summary which indicates whether the building complies.

The following discussion of the CF-1R report is divided into several sections, each corresponding to a section of the CF-1R report. An example of each section of the report is provided, followed by a discussion of that section. An example of an entire CF-1R Report is found in Figure 4-27 following Special Cases.

☞ ***NOTE - CF-1R Inputs****: Every input value that affects the energy use is listed in some form on the CF-1R Report and thus a separate copy of input data is neither necessary nor appropriate for submittals.*

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## CF-1R Special Features and Modeling Assumptions

*Figure 4-13. CF-1R Special Features and Modeling Assumptions*

SPECIAL FEATURES AND MODELING ASSUMPTIONS

*** Items in this section should be documented on the plans, ***
*** installed to manufacturer and CEC specifications, and ***
*** verified during plan check and field inspection. ***

This building incorporates a SEER 10 standard air conditioner to establish the standard design energy use and must be submitted before January 23, 2006 to be Valid.

This is a multiple orientation building. This printout is for the front facing North.

This building incorporates a Sunspace.

This building incorporates a Zonally Controlled HVAC System.

This building incorporates a Controlled Ventilation Crawlspace.

This building incorporates a Combined Hydronic Space and Water Heating System.

This building incorporates a Separate Hydronic Space Heating System.

R-5 slab insulation to a depth of 16 inches is required for hydronic radiant floor systems in a concrete slab-on-grade. The insulation is treated as an energy neutral feature and is not modeled for compliance credit. R-0 must be modeled in this climate zone.

R-10 slab insulation to a depth of 16 inches is required for hydronic radiant floor systems in a concrete slab-on-grade. The insulation is treated as an energy neutral feature and is not modeled for compliance credit. R-7 must be modeled in this climate zone.

This building incorporates non-standard Natural Vent Area or Vent Height.

This building incorporates a Housewrap/Air Infiltration Retarder.

This building incorporates a Radiant Barrier.

This building incorporates a Radiant Barrier used as part of an alteration.

This building incorporates a Cool Roof.

This building incorporates a Cool Roof used as part of an alteration.

This building incorporates Metal Framing.

This building incorporates non-standard Fenestration Shading.

This building incorporates a High Mass Design.

This building incorporates Solar Gain Targeting.

This building incorporates non-standard Duct R-value.

This building incorporates non-standard Duct Efficiency.

This building incorporates a wood space heating system.

This building does not have a cooling system installed.

Mandatory Measures require a R-12 or greater external blanket on Gas Storage Water Heaters with Energy Factors less than 0.58.

This building incorporates non-standard Water Heating System.

This building incorporates a Solar Water Heating System.
Solar system performance must be documented with SRCC documentation and either Commission approved worksheets or with F-Chart software printout.

This building incorporates a Gas Absorption Air Conditioner.

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*Figure 4-13 (cont'd). CF-1R Special Features and Modeling Assumptions*

```
This building incorporates a Distributed Energy Storage for Direct Expansion
Air Conditioning System (DES/DX-AC).

This building incorporates Mechanical Ventilation.
The Homeowner's Manual must include instructions on how to operate the windows
and/or mechanical ventilation to achieve adequate ventilation.


This building incorporates altered features. When a feature is shown as
altered, the original feature it replaces is also shown under the existing
heading. For opaque and fenestration surfaces, the existing feature is

shown before the altered feature with a number one less than the altered
feature. For Zones, Mass, HVAC systems and Water Heating, the existing
feature is shown just before the altered feature.

This building incorporates altered fenestration that includes overhangs and/or
sidefins.

The existing building incorporates higher opaque U-factors or F-factors than
the defaults for the specified vintage.

The existing building incorporates higher glazing U-factors than
the defaults for the specified vintage.

The existing building incorporates lower Heating Efficiencies than
the defaults for the specified vintage.

The existing building incorporates lower Cooling SEERs than
the defaults for the specified vintage.

The existing building incorporates lower Duct R-values than
the defaults for the specified vintage.

The existing building incorporates lower Energy Factors than
the defaults for the specified vintage.

This building incorporates HERS verified Insulation Installation.

This building incorporates HERS verified Infiltration.

This building incorporates HERS verified EER.

This building incorporates a HERS verified Refrigerant Charge test or a HERS
verified Thermostatic Expansion Valve (TXV). If a cooling system is not installed,
then HERS verification is not necessary.

This building incorporates a HERS verified Thermostatic Expansion Valve
(TXV). If a cooling system is not installed, then HERS verification is
not necessary.

This building incorporates HERS verified Maximum Cooling Capacity.

This building incorporates HERS verified Fan Power.

This building incorporates Verified Adequate Air Flow and HERS verified duct design
and layout.

This building incorporates HERS verified Buried Ducts.

This building incorporates HERS verified non-standard Duct Location.

This building incorporates HERS verified Duct Leakage.

This building incorporates HERS verified Supply Duct Surface Areas.

This building incorporates HERS verified Ducts in a Crawlspace or Basement Location.
```

These are the energy features of the building that require special notice.

MICROPAS automatically adds special feature comments when nonstandard devices or special modeling techniques are used in the compliance analysis.

## CF-1R HERS Required Verifications

*Figure 4-14. CF-1R HERS Required Verifications Sample Messages*

```
                        HERS REQUIRED VERIFICATION

       *** Items in this section require field testing and/or      ***
       *** verification by a certified home energy rater under     ***
       *** the supervision of a CEC-approved HERS provider using   ***
       *** CEC approved testing and/or verification methods and    ***
       *** must be reported on the CF-4R installation certificate. ***

This building incorporates HERS verified Insulation Installation.

This building incorporates HERS verified Infiltration.
Target and Minimum CFM values measured at 50 pascals are shown in
INFILTRATION TESTING DETAILS above. If the measured CFM50h is above
the target, then corrective action must be taken to reduce the
infiltration and then retest. Alternatively, the compliance
calculations could be redone without infiltration testing.
If the measured CFM50h is below the minimum, then the building must meet
Uniform Mechanical Code requirements for unusally tight construction and
corrective action must be taken to either intentionally increase infiltration
or provide for mechanical supply ventilation adequate to maintain the
residence at a pressure greater than -5 pascals relative to the outside
average air pressure with other continuous ventilation fans operating

This building incorporates HERS verified EER.

This building incorporates a HERS verified Refrigerant Charge test
or a HERS verified Thermostatic Expansion Valve (TXV). If a cooling
system is not installed, then HERS verification is not necessary.

This building incorporates a HERS verified Thermostatic Expansion Valve
(TXV). If a cooling system is not installed, then HERS verification is
not necessary.

This building incorporates HERS verified Fan Power.

This building incorporates Verified Adequate Air Flow and
HERS verified duct design and layout. The air conditioning system
must be verified for adequate air flow and the duct design,
layout and calculations must be included in the submittal.

This building incorporates HERS verified Maximum Cooling Capacity.

This building incorporates HERS verified Buried Ducts.

This building incorporates HERS verified non-standard Duct Location.

This building incorporates HERS verified Duct Leakage. Target leakage is
calculated and documented on the CF-4R. If the measured CFM is above the
target, then corrective action must be taken to reduce the duct leakage and
then must be retested. Alternatively, the compliance calculations could be
redone without duct testing. If ducts are not installed, then HERS
verification is not necessary.

This building incorporates HERS verified Duct Leakage. Target leakage is
calculated as 6% of fan flow. If the measured CFM25 is above the target, then
corrective action must be taken to reduce the duct leakage and then must be
retested. Alternatively, the compliance calculations could be redone without
duct testing. If ducts are not installed, then HERS verification is not
necessary.

This building incorporates HERS verified Supply Duct Surface Areas.

This building incorporates HERS verified Ducts in a Crawlspace or
Basement Location. All supply registers must be within 2 ft of floor.
This building incorporates Ducts in a Crawlspace or Basement Location.
The local enforcement agency may waive HERS verification for these locations.
```

This section of the CF-1R Report appears when compliance credit is taken for measures that require field verification and diagnostic testing as a condition of that credit. See *Residential Manual,* Chapter 4, for more information on the requirements for field verification and diagnostic testing.

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## CF-1R Remarks

*Figure 4-15. CF-1R Remarks*

REMARKS

These are comments entered by the user as an entry in the Notes section of input or made by hand after the printout of the CF-1R Report. MICROPAS will automatically add three lines for notes made by hand.

## CF-1R Compliance Statement

*Figure 4-16. CF-1R Compliance Statement*

COMPLIANCE STATEMENT

This certificate of compliance lists the building features and performance specifications needed to comply with Title-24, Parts 1 and 6 of the California Code of Regulations, and the administrative regulations to implement them. This certificate has been signed by the individual with overall design responsibility.

| DESIGNER or OWNER | | DOCUMENTATION AUTHOR | |
|---|---|---|---|
| Name.... | Arthur Doe AIA | Name.... | Sample Author |
| Company. | Doe & McClatchy | Company. | Enercomp, Inc. |
| Address. | 121 E. Broadway Ste 200 | Address. | 1721 Arroyo Drive |
| | Sacramento CA 95814 | | Auburn, CA 95603 |
| Phone... | (916) 555-2323 | Phone... | 800-755-5908 |
| License. | #23120 | | |

Names, addresses, phone numbers and signatures of the compliance documentation author and the designer or owner are required here on the CF-1R Report as part of the submittal.

# CF-1R Report: Special Cases

## CF-1R Cardinal Orientation

*Figure 4-17. CF-1R Cardinal Orientation Summary*

MICROPAS7 ENERGY USE SUMMARY

| Energy Use (kTDV/sf-yr) | Standard Design | Proposed Design | Compliance Margin |
|---|---|---|---|
| Space Heating..... | 10.99 | 12.18 | -1.19 |
| Space Cooling..... | 1.50 | 0.01 | 1.49 |
| Water Heating..... | 13.77 | 13.15 | 0.62 |
| North Total | 26.26 | 25.34 | 0.92 |
| Space Heating..... | 10.99 | 12.30 | -1.31 |
| Space Cooling..... | 1.50 | 0.03 | 1.47 |
| Water Heating..... | 13.77 | 13.15 | 0.62 |
| East Total | 26.26 | 25.48 | 0.78 |
| Space Heating..... | 10.99 | 12.52 | -1.53 |
| Space Cooling..... | 1.50 | 0.01 | 1.49 |
| Water Heating..... | 13.77 | 13.15 | 0.62 |
| South Total | 26.26 | 25.68 | 0.58 |
| Space Heating..... | 10.99 | 12.19 | -1.20 |
| Space Cooling..... | 1.50 | 0.02 | 1.48 |
| Water Heating..... | 13.77 | 13.15 | 0.62 |
| West Total | 26.26 | 25.36 | 0.90 |

*** Building complies with Computer Performance ***
*** HERS Verification Required for Compliance ***

Selecting 'Cardinal' in the RUN FEATURES menu for FRONT ORIENTATION will automatically rotate the building in four cardinal orientations. MICROPAS will expand the energy use summary to include the results for each orientation.

## CF-1R Water Heating System Credits

*Figure 4-18. CF-1R Water Heating Credits*

WATER HEATING SYSTEM CREDITS DETAIL

| System | Solar Savings Fraction | Pump Energy Included | Wood Stove Boiler | Wood Stove Pump |
|---|---|---|---|---|
| 1 Storage | 0.40 | No | n/a | n/a |

Water Heating System Credits printout will appear on CF-1R reports when 'Solar' or 'Woodstove' is selected in the HEATER BOILER section of WATER HEATING.

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## CF-1R Water Heating System Details

*Figure 4-19. CF-1R Water Heating Details*

WATER HEATING SYSTEMS DETAIL

| System | Recovery Efficiency | Rated Input | Standby Loss Fraction | Internal Tank Insulation R-value | Pilot Light |
|---|---|---|---|---|---|
| 1 Large | 0.77 | n/a | 0.03 | R-n/a | 0 |

The Water Heating Systems Detail section will appear when non-standard or unusual water heating/hydronic systems are selected, the example above is for an instantaneous boiler water heating system.

## CF-1R Hydronic Piping and Space Heating

*Figure 4-20. CF-1R Hydronic Piping and Space Heating*

HYDRONIC PIPING AND SPACE HEATING DETAIL

| System | Hydronic Type | Hydronic Delivery | Pump Energy (Watts) | Pipe Length (ft) | Pipe Diameter (in) | Insulation Thickness (in) | Insulation Conductivity (Btu/Hr-ft-F) |
|---|---|---|---|---|---|---|---|
| 1 Instantan | Combined | Radiant | n/a | 10 | 0.5 | 0.75 | 0.023 |

The Hydronic Piping and Space Heating section will appear when a combined hydronic or separate hydronic heating system is modeled.

## CF-1R Inter-zone Surfaces

*Figure 4-21. CF-1R Inter-Zone Surfaces*

INTER-ZONE SURFACES

| Surface | Area (sf) | U-factor | Insul R-val | Appendix IV Reference | Location/Comments |
|---|---|---|---|---|---|
| LIVING/SLEEPING | | | | | |
| 1 Wall | 256 | 0.293 | R-0 | None | |
| 2 Wall | 32 | 20.000 | R-0 | None | |

The Inter-Zone Surfaces section will appear in multiple zone buildings. Listed are all of the walls, floors, ceilings, windows and doors that separate any two building zones.

## CF-1R Absorbed Solar

*Figure 4-22. CF-1R Absorbed Solar*

ABSORBED SOLAR

| Surface | Area (sf) | Winter Fraction | Summer Fraction | Absorbing Thermal Mass | Area (sf) |
|---|---|---|---|---|---|
| HOUSE | | | | HOUSE | |
| 1 Window | 24.0 | 0.30 | 0.30 | 2 SlabOnGrade | 500 |

These values are the absorbed insolation fractions specified in the input data. In passive solar designs, thermal mass may be designed to directly absorb incoming solar radiation through glazings. For compliance purposes, this absorbed solar can only be directed to the thermal mass in unconditioned zones that are designed with passive solar considerations. They are not allowed for common thermal mass in conditioned spaces.

The Absorbed Solar section will appear on the CF-1R Report only if absorbed insolation fractions are specified in the input.

## CF-1R Inter-zone Ventilation

*Figure 4-23. CF-1R Inter-Zone Ventilation*

INTER-ZONE VENTILATION

| Zone Names | Vent Height (ft) | Vent Area (sf) | Location/Comments |
|---|---|---|---|
| HOUSE/SUNSPACE | 2.0 | 10 | |

This section of the CF-1R Report lists the ventilation (natural or fan) between two building zones. Ventilation between zones is normally only used when one building space can collect heat more efficiently than another space (as in the case of a sunspace attached to a house). If the heat collected by the first space is transferred to the second space via natural ventilation then an inter-zone ventilation system will be listed here on the CF-1R Report. The Inter-Zone Ventilation section will only appear on the CF-1R in multiple zone buildings that have this type of ventilation.

## CF-1R Thermal Mass

*Figure 4-24. CF-1R Thermal Mass*

THERMAL MASS

| Mass Type | Area (sf) | Thick (in) | Heat Cap | Conduct-ivity | UIMC | Surface R-value | Location/Comments |
|---|---|---|---|---|---|---|---|
| 1 SlabOnGrade | 600 | 3.5 | 28.0 | 0.98 | 4.60 | R-0.0 | Exposed |
| 2 SlabOnGrade | 1000 | 3.5 | 28.0 | 0.98 | 1.80 | R-2.0 | Covered |
| 3 InteriorVert | 40 | 1.0 | 24.0 | 0.67 | 1.70 | R-0.0 | Bath Tile Wall |
| 4 InteriorHorz | 80 | 1.0 | 24.0 | 0.67 | 1.70 | R-0.0 | Entry Tile Floor |

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In a building that exceeds the high mass threshold (see Chapter 2, Input Reference), these values represent the size, location and thermal characteristics of the thermal mass surfaces of the building (such slab floors, masonry walls, tile, masonry fireplaces, etc). A high mass design is reported in the Special Features and Modeling Assumptions.

### Special Notes

*Heat Capacity and Conductivity* The volumetric heat capacity (in Btu/ft$^3$-°F) and conductivity (Btu-in/hr-ft$^2$-°F) of the thermal mass material used in MICROPAS are listed in Chapter 2, Input Reference, or can be taken from references such as *ASHRAE Fundamentals*.

*UIMC* The Unit Interior Mass Capacity values used in MICROPAS are listed in Chapter 2, Input Reference.

*Surface R-value* The surface R-value listed here is normally R-0.0, or in the case of covered slab, R-2.0. This is the value of the mass surface covering without including the R-value of the surface air film.

## CF-1R Exterior Mass

*Figure 4-25. CF-1R Exterior Mass*

OPAQUE SURFACES

| Surface | Frame Type | Area (sf) | U-factor | Cavity R-val | Sheathing R-val | Act Azm | Tilt | Solar Gains | Appendix IV Reference | Location/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 Wall | | 204 | 0.102 | 13 | 0 | 0 | 90 | Yes | IV.9 A3 | |
| 6 Wall | | 264 | 0.102 | 13 | 0 | 90 | 90 | Yes | IV.9 A3 | |
| 7 Wall | | 192 | 0.102 | 13 | 0 | 180 | 90 | Yes | IV.9 A3 | |
| 4 ExteriorVert (Thermal Mass) | | | | | | | | | | |
| 1 Wall | | 204 | 0.164 | 7 | 0 | 0 | 90 | Yes | IV.14 A2 | |
| 2 Wall | | 264 | 0.164 | 7 | 0 | 90 | 90 | Yes | IV.14 A2 | |
| 3 Wall | | 192 | 0.164 | 7 | 0 | 180 | 90 | Yes | IV.14 A2 | |
| 4 Wall | | 288 | 0.164 | 7 | 0 | 270 | 90 | Yes | IV.14 A2 | |

THERMAL MASS

| Mass Type | Area (sf) | Thick (in) | Heat Cap | Conductivity | UIMC | Surface R-value | Location/Comments |
|---|---|---|---|---|---|---|---|
| HOUSE | | | | | | | |
| 1 SlabOnGrade | 240 | 3.5 | 28.0 | 0.98 | 4.60 | R-0.0 | Exposed |
| 2 SlabOnGrade | 1360 | 3.5 | 28.0 | 0.98 | 1.80 | R-2.0 | Covered |
| 3 ExteriorVert | 948 | 8.0 | 28.0 | 0.98 | 1.80 | R-0.0 | Exterior Mass Wall |

Heavyweight construction assemblies exposed to the exterior such as filled block walls or suspended slab floors over garages are known as *exterior mass*. Input data to describe the exterior mass is listed in two sections of the CF-1R Report. The Opaque Surface section lists the orientation, the overall U-factor and exterior insulation R-value of the exterior mass. The Thermal Mass section lists the properties of the mass material and the interior insulation R-value.

Note that for an exterior mass, the mass type ('ExteriorHorz' or 'ExteriorVert') will appear above the opaque surfaces instead of the building zone name that normally appears above the opaque surfaces.

### Special Notes

*U-factor* The U-factor listed for an exterior mass is calculated by MICROPAS by combining the effects of the interior and exterior insulation (see below), the steady-state thermal resistance of the mass and the interior and exterior air films (see Appendix E, Program Assumptions, for assumed values).

*Insulation R-value* For exterior mass, the insulation level is the sum of values listed on the CF-1R Report in the Cavity and Sheathing R-value columns in the Opaque Surfaces section.

## CF-1R Fan System Ventilation

*Figure 4-26. CF-1R Fan System Ventilation*

FAN SYSTEMS

| System Type | Flow (cfm) | Power (W/cfm) |
|---|---|---|
| HOUSE | | |
| UnBalanced | 80 | 1.000 |

In a building where mechanical ventilation is required because the building envelope leakage is significantly reduced, a Fan Systems section will be printed on the CF-1R. See Chapter 2, Input Reference, and *Residential Manual*, Chapter 4, for more information on fan ventilation.

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# CF-1R Certificate of Compliance – Residential Computer Method

*Figure 4-27. CF-1R Report*

CERTIFICATE OF COMPLIANCE: RESIDENTIAL COMPUTER METHOD CF-1R Page 1

Project Title..... Sample Micropas Run Date..09/15/05 09:28:15
Project Address..... 2300 Mace Ave *******
Modesto CA *v7.10*
Documentation Author... Sample Author *******
Enercomp, Inc.
1721 Arroyo Dr.
Auburn, CA 95603
800-755-5908
Climate Zone..... 12
Compliance Method..... MICROPAS7 v7.10 for 2005 Standards by Enercomp, Inc.

Building Permit #
Plan Check / Date
Field Check/ Date

MICROPAS7 v7.10 File-MP7BASE Wth-CTZ12S05 Program-FORM CF-1R
User#-MP0101 User-Enercomp, Inc. Run-Sample

MICROPAS7 ENERGY USE SUMMARY

| Energy Use (kTDV/sf-yr) | Standard Design | Proposed Design | Compliance Margin |
|---|---|---|---|
| Space Heating..... | 15.19 | 17.06 | -1.87 |
| Space Cooling..... | 11.97 | 10.11 | 1.86 |
| Water Heating..... | 13.53 | 12.91 | 0.62 |
| Total | 40.69 | 40.08 | 0.61 |

*** Building complies with Computer Performance ***
*** HERS Verification Required for Compliance ***

GENERAL INFORMATION

| | |
|---|---|
| HERS Verification..... | Required |
| Conditioned Floor Area..... | 1600 sf |
| Building Type..... | Single Family Detached |
| Construction Type ..... | New |
| Fuel Type ..... | NaturalGas |
| Building Front Orientation. | Front Facing 0 deg (N) |
| Number of Dwelling Units... | 1 |
| Number of Building Stories. | 1 |
| Weather Data Type..... | FullYear |
| Floor Construction Type.... | Slab On Grade |
| Number of Building Zones... | 1 |
| Conditioned Volume..... | 12800 cf |
| Slab-On-Grade Area..... | 1600 sf |
| Glazing Percentage..... | 16.5 % of floor area |
| Average Glazing U-factor... | 0.65 Btu/hr-sf-F |
| Average Glazing SHGC..... | 0.4 |
| Average Ceiling Height..... | 8 ft |

BUILDING ZONE INFORMATION

| Zone Type | Floor Area (sf) | Volume (cf) | # of Dwell Units | # of Peop-le | Cond-it-ioned | Thermo-stat Type | Vent Height (ft) | Vent Area (sf) | Verified Leakage or Housewrap |
|---|---|---|---|---|---|---|---|---|---|
| Residence | 1600 | 12800 | 1.00 | 4.0 | Yes | Setback | 2.0 | Standard | No |

*Figure 4-27 (cont'd). CF-1R Report*

CERTIFICATE OF COMPLIANCE: RESIDENTIAL COMPUTER METHOD CF-1R Page 2

Project Title..... Sample Micropas Run Date..09/15/05 09:28:15

MICROPAS7 v7.10 File-MP7BASE Wth-CTZ12S05 Program-FORM CF-1R
User#-MP0101 User-Enercomp, Inc. Run-Sample

OPAQUE SURFACES

| Surface | Frame Type | Area (sf) | U-factor | Cavity R-val | Sheathing R-val | Act Azm | Tilt | Solar Gains | Appendix IV Reference | Location/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Wall | Wood | 204 | 0.102 | 13 | 0 | 0 | 90 | Yes | IV.9 A3 | |
| 2 Wall | Wood | 264 | 0.102 | 13 | 0 | 90 | 90 | Yes | IV.9 A3 | |
| 3 Wall | Wood | 192 | 0.102 | 13 | 0 | 180 | 90 | Yes | IV.9 A3 | |
| 4 Wall | Wood | 288 | 0.102 | 13 | 0 | 270 | 90 | Yes | IV.9 A3 | |
| 5 Wall | Wood | 37 | 0.102 | 13 | 0 | 45 | 90 | Yes | IV.9 A3 | Corner Wall |
| 6 RoofRad | Wood | 1592 | 0.026 | 38 | 0 | n/a | 0 | Yes | IV.1 A8 | |
| 7 Door | Other | 20 | 0.500 | 0 | 0 | 0 | 90 | Yes | IV.5 A4 | |

PERIMETER LOSSES

| Surface | Length (ft) | F2 Factor | Insul R-val | Solar Gains | Appendix IV Reference | Location/ Comments |
|---|---|---|---|---|---|---|
| 8 SlabEdge | 160 | 0.730 | R-0 | No | IV.26 A1 | |

FENESTRATION SURFACES

| Orientation | Area (sf) | U-factor | SHGC | Act Azm | Tilt | Exterior Shade Type | Location/Comments |
|---|---|---|---|---|---|---|---|
| 1 Wind Front (N) | 24.0 | 0.650 | 0.400 | 0 | 90 | Standard | F1/Metal Operable Low E2 |
| 2 Wind Front (N) | 40.0 | 0.650 | 0.400 | 0 | 90 | Standard | F2/Metal Fixed Low E2 |
| 3 Wind Left (E) | 24.0 | 0.650 | 0.400 | 90 | 90 | Standard | L1/Metal Operable Low E2 |
| 4 Wind Back (S) | 48.0 | 0.650 | 0.400 | 180 | 90 | Standard | B1/Metal Operable Low E2 |
| 5 Door Back (S) | 80.0 | 0.650 | 0.400 | 180 | 90 | Standard | B2/Metal Patio Door Low |
| 6 Wind Right (W) | 32.0 | 0.650 | 0.400 | 270 | 90 | Standard | R1/Metal Operable Low E2 |
| 7 Wind Front (NE) | 8.0 | 0.650 | 0.400 | 45 | 90 | Standard | C1/Metal Fixed Low E2 |
| 8 Skyl Front (N) | 8.0 | 0.750 | 0.400 | 0 | 23 | None | SKY1/Metal Skylight Low |

OVERHANGS

| | Window | | Overhang | | | |
|---|---|---|---|---|---|---|
| Surface | Area (sf) | Width | Height | Depth | Height | Left Extension | Right Extension |
| 1 Window | 24.0 | n/a | 4.0 | 2.0 | 1.5 | n/a | n/a |
| 2 Window | 40.0 | n/a | 5.0 | 2.0 | 1.5 | n/a | n/a |
| 3 Window | 24.0 | n/a | 5.0 | 2.0 | 0.5 | n/a | n/a |
| 4 Window | 48.0 | n/a | 4.0 | 2.0 | 0.5 | n/a | n/a |
| 5 Door | 80.0 | n/a | 6.7 | 2.0 | 0.5 | n/a | n/a |
| 6 Window | 32.0 | n/a | 4.0 | 2.0 | 0.5 | n/a | n/a |

SLAB SURFACES

| Slab Type | Area (sf) |
|---|---|
| Standard Slab | 1600 |

HVAC SYSTEMS

| System Type | Number of Systems | Minimum Efficiency | Verified EER | Verified Refrig Charge or TXV | Verified Adequate Airflow | Verified Fan Watt Draw | Verified Maximum Cooling Capacity |
|---|---|---|---|---|---|---|---|
| Furnace | 1 | 0.800 AFUE | n/a | n/a | n/a | n/a | n/a |
| ACSplit | 1 | 13.00 SEER | No | Yes | No | No | No |

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*Figure 4-27 (cont'd). CF-1R Report*

CERTIFICATE OF COMPLIANCE: RESIDENTIAL COMPUTER METHOD CF-1R Page 3

Project Title..... Sample Micropas Run Date..09/15/05 09:28:15

MICROPAS7 v7.10 File-MP7BASE Wth-CTZ12S05 Program-FORM CF-1R
User#-MP0101 User-Enercomp, Inc. Run-Sample

HVAC SIZING

| System Type | Total Heating Load (Btu/hr) | Sensible Cooling Load (Btu/hr) | Design Cooling Capacity (Btu/hr) | Verified Maximum Cooling Capacity (Btu/hr) |
|---|---|---|---|---|
| Furnace | 32554 | n/a | n/a | n/a |
| ACSplit | n/a | 17229 | 20530 | n/a |

Sizing Location..... MODESTO
Winter Outside Design..... 25 F
Winter Inside Design..... 70 F
Summer Outside Design..... 98 F
Summer Inside Design..... 75 F
Summer Range..... 36 F

DUCT SYSTEMS

| System Type | Duct Location | Duct R-value | Verified Duct Leakage | Verified Surface Area | Verified Buried Ducts |
|---|---|---|---|---|---|
| Furnace | Attic | R-6 | Yes | No | No |
| ACSplit | Attic | R-6 | Yes | No | No |

WATER HEATING SYSTEMS

| Tank Type | Heater Type | Distribution Type | Number in System | Energy Factor | Tank Size (gal) | External Insulation R-value |
|---|---|---|---|---|---|---|
| 1 Storage | Gas | Standard | 1 | 0.60 | 50 | R- n/a |

SPECIAL FEATURES AND MODELING ASSUMPTIONS

*** Items in this section should be documented on the plans, ***
*** installed to manufacturer and CEC specifications, and ***
*** verified during plan check and field inspection. ***

This building incorporates a HERS verified Refrigerant Charge test or a HERS verified Thermostatic Expansion Valve (TXV). If a cooling system is not installed, then HERS verification is not necessary.

This building incorporates HERS verified Duct Leakage.

This building incorporates a Radiant Barrier.

HERS REQUIRED VERIFICATION

*** Items in this section require field testing and/or ***
*** verification by a certified home energy rater under ***
*** the supervision of a CEC-approved HERS provider using ***
*** CEC approved testing and/or verification methods and ***
*** must be reported on the CF-4R installation certificate. ***

This building incorporates a HERS verified Refrigerant Charge test or a HERS verified Thermostatic Expansion Valve (TXV). If a cooling system is not installed, then HERS verification is not necessary.

This building incorporates HERS verified Duct Leakage. Target leakage is calculated and documented on the CF-4R. If the measured CFM is above the target, then corrective action must be taken to reduce the duct leakage and then must be retested. Alternatively, the compliance calculations could be redone without duct testing. If ducts are not installed, then HERS verification is not necessary.

*Figure 4-27 (cont'd). CF-1R Report*

CERTIFICATE OF COMPLIANCE: RESIDENTIAL COMPUTER METHOD CF-1R Page 4

Project Title..... Sample Micropas Run Date..09/15/05 09:28:15

MICROPAS7 v7.10 File-MP7BASE Wth-CTZ12S05 Program-FORM CF-1R
User#-MP0101 User-Enercomp, Inc. Run-Sample

REMARKS

COMPLIANCE STATEMENT

This certificate of compliance lists the building features and performance specifications needed to comply with Title-24, Parts 1 and 6 of the California Code of Regulations, and the administrative regulations to implement them. This certificate has been signed by the individual with overall design responsibility.

| DESIGNER or OWNER | DOCUMENTATION AUTHOR |
|---|---|
| Name.... Arthur Doe AIA | Name.... Samuel T. Smith |
| Company. Doe & McClatchy | Company. Enercomp, Inc. |
| Address. 121 E. Broadway Ste 200 | Address. 1721 Arroyo Drive |
| Sacramento CA 95814 | Auburn, CA 95603 |
| Phone... (916) 555-2323 | Phone... 800-755-5908 |
| License. #23120 | |
| Signed.. _____ (date) | Signed.. _____ (date) |

ENFORCEMENT AGENCY

Name.... _____
Title... _____
Agency.. _____
_____
Phone... _____

Signed.. _____ (date)

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# Mandatory Measures Report

The *MF-1R Mandatory Measures Report* provides a checklist of mandatory features the building must incorporate for compliance. The *Residential Manual* describes the mandatory features in detail.

*Figure 4-28. MF-1R Mandatory Measures Report*

```
MANDATORY MEASURES CHECKLIST: RESIDENTIAL                          MF-1R    Page 1
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Project Title.......... Sample Micropas Run              Date..09/16/05 15:56:45
Project Address........ 2300 Mace Ave            *******
                        Modesto CA               *v7.10*   ┌──────────────────┐
Documentation Author... Sample Author            *******   │ Building Permit # │
                        Enercomp, Inc.                     │                  │
                        1721 Arroyo Drive                  │ Plan Check / Date │
                        Auburn, CA  95603                  │                  │
                        800-755-5908                       │ Field Check/ Date │
Climate Zone........... 12                                 └──────────────────┘
Compliance Method...... MICROPAS7 v7.10 for 2005 Standards by Enercomp, Inc.
═══════════════════════════════════════════════════════════════════════════════
     MICROPAS7 v7.10  File-MP7BASEE  Wth-CTZ12S05  Program-FORM MF-1R
               User#-MP0101  User-Enercomp, Inc.  Run-Sample
```

Note: Lowrise residential buildings subject to the Standards must contain these measures regardless of the compliance approach used. More stringent compliance requirements from the Certificate of Compliance supersede the items marked with an asterisk (*). When this checklist is incorporated into the permit documents, the features noted shall be considered by all parties as minimum component performance specifications for the mandatory measures whether they are shown elsewhere in the documents or on this checklist only.

| BUILDING ENVELOPE MEASURES | n/a | De-signer | En-force-ment |
|---|---|---|---|
| *150(a): Minimum R-19 insulation in wood framed ceiling or equivalent U-factor in metal frame ceiling | ____ | ____ | ____ |
| 150(b): Loose fill insulation manufacturer's labeled R-Value | ____ | ____ | ____ |
| *150(c): Minimum R-13 wall insulation in wood framed walls or equivalent U-factor in metal frame walls (does not apply to exterior mass walls) | ____ | ____ | ____ |
| *150(d): Minimum R-13 raised floor insulation in framed floors or equivalent U-factor | ____ | ____ | ____ |
| 150(e): Installation of Fireplaces, Decorative Gas Appliances and Gas Logs | | | |
| 1. Masonry and factory-built fireplaces have: | | | |
| a. Closeable metal or glass door covering the entire opening of the firebox | ____ | ____ | ____ |
| b. Outside air intake with damper and control, flue damper and control | ____ | ____ | ____ |
| 2. No continuous burning gas pilot lights allowed | ____ | ____ | ____ |
| 150(f): Air retarding wrap installed to comply with Sec. 151 meets requirements specified in ACM Residential Manual | ____ | ____ | ____ |
| 150(g): Vapor barriers mandatory in Climate Zones 14,16 only | ____ | ____ | ____ |
| 150(l): Slab edge insulation - water absorption rate for the insulation material without facings no greater than 0.3%, water vapor permeance rate no greater than 2.0 perm/inch | ____ | ____ | ____ |
| 118: Insulation specified or installed meets insulation quality standards. Indicate type and include CF-6R form | ____ | ____ | ____ |
| 116-17: Fenestration Products, Exterior Doors and Infiltration/ Exfiltration Controls | | | |
| 1. Doors and windows between conditioned and unconditioned spaces designed to limit air leakage | ____ | ____ | ____ |
| 2. Fenestration products (except field-fabricated) have label with certified U-factor, certified Solar Heat Gain Coefficient (SHGC), and infiltration certification | ____ | ____ | ____ |
| 3. Exterior doors and windows weatherstripped; all joints and penetrations caulked and sealed | ____ | ____ | ____ |

*Figure 4-28. MF-1R Mandatory Measures Report*

```
MANDATORY MEASURES CHECKLIST: RESIDENTIAL                Page 2          MF-1R
Project Title..... Sample Micropas Run             Date..09/16/05 15:56:45
     MICROPAS7 v7.10  File-MP7BASEE  Wth-CTZ12S05  Program-FORM MF-1R
                User#-MP0101  User-Enercomp, Inc.  Run-Sample

SPACE CONDITIONING, WATER HEATING AND PLUMBING SYSTEM MEASURES      De-   En-
                                                                   sign- force
                                                          n/a      er    ment
 110-113: HVAC equipment, water heaters, showerheads and
   faucets certified by the Energy Commission             ____  ____  ____
 150(h): Heating and/or cooling loads calculated in accordance
   with ASHRAE, SMACNA or ACCA                            ____  ____  ____
 150(i): Setback thermostat on all applicable heating and/or
   cooling systems                                        ____  ____  ____
 150(j): Water system pipe and tank insulation and cooling
   systems line insulation
   1. Storage gas water heaters rated with an Energy Factor
      less than 0.58 must be externally wrapped with insulation
      having an installed thermal resistance of R12 or greater____  ____  ____
   2. Back-up tanks for solar system, unfired storage tanks, or
      other indirect hot water tanks have R-12 external
      insulation or R-16 internal and indicated on the
      exterior of the tank showing the R-value            ____  ____  ____
   3. The following piping is insulated according to Table 150-A/B
      or Equation 150-A Insulation Thickness:
        1. First 5 feet of hot and cold water pipes closest to
           water heater tank, non-recirculating systems, and
           entire length of recirculating sections of hot water
           pipes shall be insulated to Table 150B         ____  ____  ____
        2. Cooling system piping (suction, chilled water, or
           brine lines), piping insulated between heating source
           and indirect hot water tank shall be insulated to
           Table 150-B and Equation 150-A                 ____  ____  ____
   4. Steam hydronic heating systems or hot water systems >15 psi,
      meet requirements of Table 123-A                    ____  ____  ____
   5. Insulation must be protected from damage, including that due
      to sunlight, moisture, equipment maintenance and wind ____  ____  ____
   6. Insulation for chilled water piping and refrigerant suction
      piping includes a vapor retardant or is enclosed entirely
      in conditioned space                                ____  ____  ____
   7. Solar water-heating systems/collectors are certified by the
      Solar Rating and Certification Corporation          ____  ____  ____
*150(m): Ducts and Fans
   1. All ducts and plenums installed, sealed and insulated to
      meet the requirements of the CMC Sections 601, 602, 603,
      604, 605 and Standard 6-5; supply-air and return-air ducts
      and plenums are insulated to a minimum installed level of
      R-4.2 or enclosed entirely in conditioned space. Openings
      shall be sealed with mastic, tape, or other duct-closure
      system that meets the applicable requirements of UL 181,
      UL 181A, or UL 181B or aerosol sealant that meets the
      requirements of UL 723.  If mastic or tape is used to seal
      openings greater than 1/4 inch, the combination of mastic
      and either mesh or tape shall be used               ____  ____  ____
   2. Building cavities, support platforms for air handlers, and
      plenums defined or constructed with materials other than
      sealed sheet metal, duct board or flexible duct shall not
      be used for conveying conditioned air. Building cavities and
      support platforms may contain ducts. Ducts installed in
      cavities and support platforms shall not be compressed to cause
      reductions in the cross-sectional area of the ducts ____  ____  ____
   3. Joints and seams of duct systems and their components
      shall not be sealed with cloth backed rubber adhesive
      duct tapes unless such tape is used in combination with
      mastic and draw bands                              ____  ____  ____
   4. Exhaust fan systems have back draft or automatic dampers____  ____  ____
   5. Gravity ventilating systems serving conditioned space have
      either automatic or readily accessible, manually
      operated dampers                                   ____  ____  ____
```

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*Figure 4-28. MF-1R Mandatory Measures Report*

MANDATORY MEASURES CHECKLIST: RESIDENTIAL Page 3 MF-1R

Project Title..... Sample Micropas Run Date..09/16/05 15:56:45

MICROPAS7 v7.10 File-MP7BASEE Wth-CTZ12S05 Program-FORM MF-1R
User#-MP0101 User-Enercomp, Inc. Run-Sample

| | | | |
|---|---|---|---|
| 6. Protection of Insulation. Insulation shall be protected from damage due to sunlight, moisture, equipment maintenance and wind. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material | ____ | ____ | ____ |
| 7. Flexible ducts cannot have porous inner cores | ____ | ____ | ____ |
| 114: Pool and Spa Heating Systems and Equipment | | | |
| 1. A thermal efficiency that complies with the Appliance Efficiency Regulations, on-off switch mounted outside of the heater, weatherproof operating instructions, no electric resistance heating and no pilot light | ____ | ____ | ____ |
| 2. System is installed with: a. At least 36 inches of pipe between filter and heater for future solar heating | | | |
| b. Cover for outdoor pools or outdoor spas. | ____ | ____ | ____ |
| 3. Pool system has directional inlets and a circulation pump time switch | ____ | ____ | ____ |
| 115: Gas-fired central furnaces, pool heaters, spa heaters or household cooking appliances have no continuously burning pilot light (Exception: Non-electrical cooking appliances with pilot < 150 Btu/hr) | ____ | ____ | ____ |
| 118(i): Cool Roof material meets specified criteria | ____ | ____ | ____ |

| RESIDENTIAL LIGHTING MEASURES | n/a | De-signer | En-force ment |
|---|---|---|---|
| 150(k)1: HIGH EFFICACY LUMINAIRES OTHER THAN OUTDOOR HID: contain only high efficacy lamps as outlined in Table 150-C, and do not contain a medium screw base socket (E24/E26). Ballast for lamps 13 watts or greater are electronic and have an output frequency no less than 20 kHz | ____ | ____ | ____ |
| 150(k)1: HIGH EFFICACY LUMINAIRES - OUTDOOR HID: contain only high efficacy lamps as outlined in Table 150-C, luminaire has factory installed HID ballast | ____ | ____ | ____ |
| 150(k)2: Permanently installed luminaires in kitchens shall be high efficacy luminaires. Up to 50 percent of the wattage, as determined in Sec. 130(c), of permanently installed luminaires in kitchens may be in luminaires that are not high efficacy luminaires, provided that these luminaires are controlled by switches separate from those controlling the high efficacy luminaires | ____ | ____ | ____ |
| 150(k)3: Permanently installed luminaires in bathrooms, garages, laundry rooms, utility rooms shall be high efficacy luminaires OR are controlled by an occupant sensor(s) certified to comply with Section 119(d) that does not turn on automatically or have an always on option | ____ | ____ | ____ |
| 150(k)4: Permanently installed luminaires located other than in kitchens, bathrooms, garages, laundry rooms, and utility rooms shall be high efficacy luminaires (except closets less than 70 ft2), OR are controlled by a dimmer switch OR are controlled by an occupant sensor(s) that complies with Section 119(d) that does not turn on automatically or have an always on option | ____ | ____ | ____ |
| 150(k)5: Luminaires that are recessed into insulated ceilings are approved for zero clearance insulation cover (IC) and are certified air tight to ASTM E283 and labeled as air tight (AT) to less than 2.0 CFM at 75 Pascals | ____ | ____ | ____ |
| 150(k)6: Luminaires providing outdoor lighting and permanently mounted to a residential building or to other buildings on the same lot shall be high efficacy luminaires (not including lighting around swimming pools/water features or other Article 680 locations) OR are controlled by occupant sensors with integral photo control certified to comply with Section 119(d) | ____ | ____ | ____ |
| 150(k)7: Lighting for parking lots for 8 or more vehicles shall have lighting that complies with Sec. 130, 132, and 147. Lighting for parking garages for 8 or more vehicles shall have lighting that complies with Sec. 130, 131, and 146 | ____ | ____ | ____ |

*Figure 4-28. MF-1R Mandatory Measures Report*

```
MANDATORY MEASURES CHECKLIST: RESIDENTIAL                Page 4          MF-1R
═══════════════════════════════════════════════════════════════════════════════
Project Title.......... Sample Micropas Run            Date..09/16/05 15:56:45
┌─────────────────────────────────────────────────────────────────────────────┐
│     MICROPAS7 v7.10  File-MP7BASEE  Wth-CTZ12S05  Program-FORM MF-1R        │
│               User#-MP0101  User-Enercomp, Inc.  Run-Sample                 │
└─────────────────────────────────────────────────────────────────────────────┘
150(k)8: Permanently installed lighting in the enclosed, non-
   dwelling spaces of low-rise residential buildings with four
   or more dwelling units shall be high efficacy luminaires OR
   are controlled by an occupant sensor(s) certified to
   comply with Section 119(d)                                  ____  ____  ____
```

# HVAC Sizing Reports

The HVAC Sizing reports are available in two levels of detail. The detail of the report is selected with the input value HVAC SIZING CALCULATIONS found in the *Calculations and Reports* section of input data.

The *Summary* report is a single page summarizing the indoor and outdoor design conditions and summarizing the loads. As the CF-1R report now includes a section on HVAC sizing, additional sizing pages are not normally required for compliance submittals.

The *Detailed* report is two or more pages detailing each calculation within the MICROPAS sizing methodology. The HVAC Sizing Summary report is included as the first page of the detailed sizing reports.

☞ ***NOTE - Detailed Reports:*** *Because of its length and complexity, the* Detailed Report *is not recommended for compliance submittals.*

**Multi-Zone Buildings**

If your building has more than one zone, the *Summary* report will contain multiple pages of sizing calculations. The first page will contain calculations for the building as a whole. The subsequent pages will contain calculations for each of the building zones. These latter pages can be used to size equipment on a zone-by-zone or room-by-room basis depending how the building is divided.

**Example Reports**

The next section provides examples of the following HVAC Sizing reports:

- Single Zone Building Sizing Summary Report
- Multi-zone Building Sizing Summary Report
- Sizing Detailed Report (for Single Zone Building)

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*Figure 4-29. Single Zone Building Sizing Summary Report*

Project Title..... Sample Micropas Run Date..09/15/05 11:54:52

MICROPAS7 v7.10 File-MP7BASE Wth-CTZ12S05 Program-FORM CF-1R
User#-MP0101 User-Enercomp, Inc. Run-Cardinal Orientation

GENERAL INFORMATION

Floor Area..... 1600 sf
Volume..... 12800 cf
Front Orientation..... Front Facing 0 deg (N)
Sizing Location..... MODESTO
Latitude..... 37.6 degrees
Winter Outside Design..... 25 F
Winter Inside Design..... 70 F
Summer Outside Design..... 98 F
Summer Inside Design..... 75 F
Summer Range..... 36 F
Interior Shading Used..... Yes
Exterior Shading Used..... Yes
Overhang Shading Used..... Yes
Latent Load Fraction..... 0.19

HEATING AND COOLING LOAD SUMMARY

| Description | Heating (Btu/hr) | Cooling (Btu/hr) |
|---|---|---|
| Opaque Conduction and Solar..... | 14241 | 3729 |
| Glazing Conduction and Solar..... | 7758 | 6950 |
| Infiltration..... | 6192 | 1915 |
| Internal Gain..... | n/a | 2520 |
| Ducts..... | 4363 | 2116 |
| Sensible Load..... | 32554 | 17229 |
| Latent Load..... | n/a | 3301 |
| Minimum Total Load | 32554 | 20530 |

Note: The loads shown are only one of the criteria affecting the selection of HVAC equipment. Other relevant design factors such as air flow requirements, outside air, outdoor design temperatures, coil sizing, availability of equipment, oversizing safety margin, etc., must also be considered. It is the HVAC designer's responsibility to consider all factors when selecting the HVAC equipment.

*Figure 4-30. Multi-Zone Building Sizing Summary Report*

HVAC SIZING HVAC Page 2

Project Title..... Sample Micropas Run Date..09/15/05 11:54:52

MICROPAS7 v7.10 File-MP7BASE Wth-CTZ12S05 Program-FORM CF-1R
User#-MP0101 User-Enercomp, Inc. Run-Cardinal Orientation

HEATING AND COOLING LOAD SUMMARY BY ZONE

ZONE 'LIVING'

Floor Area..... 800 sf
Volume..... 6400 cf

| Description | Heating (Btu/hr) | Cooling (Btu/hr) |
|---|---|---|
| Opaque Conduction and Solar..... | 6507 | 1599 |
| Glazing Conduction and Solar..... | 5024 | 6591 |
| Infiltration..... | 3096 | 957 |
| Internal Gain..... | n/a | 2520 |
| Ducts..... | 2264 | 1633 |
| Sensible Load..... | 16890 | 13300 |
| Latent Load..... | n/a | 2548 |
| Minimum Zone Load | 16890 | 15849 |

ZONE 'SLEEPING'

Floor Area..... 800 sf
Volume..... 6400 cf

| Description | Heating (Btu/hr) | Cooling (Btu/hr) |
|---|---|---|
| Opaque Conduction and Solar..... | 5994 | 1456 |
| Glazing Conduction and Solar..... | 4300 | 4946 |
| Infiltration..... | 3096 | 957 |
| Internal Gain..... | n/a | 0 |
| Ducts..... | 2072 | 1030 |
| Sensible Load..... | 15462 | 8389 |
| Latent Load..... | n/a | 1607 |
| Minimum Zone Load | 15462 | 9996 |

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*Figure 4-31. Sizing Detailed Report*

HVAC SIZING HVAC Page 2

Project Title..... Sample Micropas Run Date..09/15/05 11:54:52

MICROPAS7 v7.10 File-MP7BASE Wth-CTZ12S05 Program-FORM CF-1R
User#-MP0101 User-Enercomp, Inc. Run-Cardinal Orientation

HEATING LOAD CALCULATIONS

DESIGN CONDITIONS FOR ZONE 'HOUSE':

WINTER DESIGN TEMPERATURES:
Inside Temperature..... 70.0 F
Outside Temperature..... 25.0 F

DESIGN TEMPERATURE DIFFERENCES
Standard..... 45.0 F

CONDUCTIVE HEAT LOSS:

| Description | Orientation | Area (sf) | | U-factor (Btu/hr-sf-F) | | TD (F) | | Heat Loss (Btu/hr) |
|---|---|---|---|---|---|---|---|---|
| Wall | North | 204.0 | x | 0.1214 | x | 45.0 | = | 1114 |
| Wall | East | 264.0 | x | 0.1214 | x | 45.0 | = | 1442 |
| Wall | South | 192.0 | x | 0.1214 | x | 45.0 | = | 1049 |
| Wall | West | 288.0 | x | 0.1214 | x | 45.0 | = | 1573 |
| Wall | Northeast | 37.0 | x | 0.1214 | x | 45.0 | = | 202 |
| Roof | Horizontal | 1592.0 | x | 0.0440 | x | 45.0 | = | 3155 |
| Door | North | 20.0 | x | 0.5000 | x | 45.0 | = | 450 |
| SlabEdge | n/a | 160.0 | x | 0.7300 | x | 45.0 | = | 5256 |
| | CONDUCTIVE TOTALS FOR OPAQUE SURFACES | | | | | | | 14241 |
| Window | North | 24.0 | x | 0.6500 | x | 45.0 | = | 702 |
| Window | North | 40.0 | x | 0.6500 | x | 45.0 | = | 1170 |
| Window | East | 24.0 | x | 0.6500 | x | 45.0 | = | 702 |
| Window | South | 48.0 | x | 0.6500 | x | 45.0 | = | 1404 |
| Door | South | 80.0 | x | 0.6500 | x | 45.0 | = | 2340 |
| Window | West | 32.0 | x | 0.6500 | x | 45.0 | = | 936 |
| Window | Northeast | 8.0 | x | 0.6500 | x | 45.0 | = | 234 |
| Skylight | Horizontal | 8.0 | x | 0.7500 | x | 45.0 | = | 270 |
| | CONDUCTIVE TOTALS FOR GLAZING SURFACES | | | | | | | 7758 |

INFILTRATION: (Type: Standard)
12800 cuft x 0.60 ac/hr x 0.018 Btu/cuft-F x 45.0 = 6192

SUBTOTAL 28191

DUCT HEAT LOSS: Duct Location: Attic 0.155 x 28191 = 4363

TOTAL HEATING LOAD: 32554

*Figure 4-31 (cont'd). Sizing Detailed Report*

HVAC SIZING HVAC Page 3

Project Title..... Sample Micropas Run Date..09/15/05 11:54:52

MICROPAS7 v7.10 File-MP7BASE Wth-CTZ12S05 Program-FORM CF-1R
User#-MP0101 User-Enercomp, Inc. Run-Cardinal Orientation

COOLING LOAD CALCULATIONS

DESIGN CONDITIONS FOR ZONE 'HOUSE':

SUMMER DESIGN CONDITIONS:
Inside Temperature..... 75.0 F
Outside Temperature..... 98.0 F
Temperature Range..... 36.0 F

DESIGN EQUIVALENT TEMPERATURE DIFFERENCES
Standard..... 23.0 F

SHADING CALCULATIONS:

| Description | O. | Shade Line Fact. | Over-hang Leng. (ft) | Over-hang High. (ft) | Shade High. (ft) | Glaz High. (ft) | Glaz Area (sf) | Shaded Area (sf) | Un-shaded Area (sf) |
|---|---|---|---|---|---|---|---|---|---|
| Window | E | ( 0.8 x | 2.0) - | 0.5 = | 1.1 / | 5.0 x | 24 = | 5.3 | 18.7 |
| Window | S | ( 3.1 x | 2.0) - | 0.5 = | 5.7 / | 4.0 x | 48 = | 67.9 | 0.0 |
| Door | S | ( 3.1 x | 2.0) - | 0.5 = | 5.7 / | 6.7 x | 80 = | 67.6 | 12.4 |
| Window | W | ( 0.8 x | 2.0) - | 0.5 = | 1.1 / | 4.0 x | 32 = | 8.8 | 23.2 |

CONDUCTIVE AND SOLAR HEAT GAIN:

| Description | Orientation | Area (sf) | | U-factor (Btu/hr-sf-F) | | CLTD (F) | | Heat Gain (Btu/hr) |
|---|---|---|---|---|---|---|---|---|
| Wall | North | 204.0 | x | 0.1214 | x | 11.0 | = | 272 |
| Wall | East | 264.0 | x | 0.1214 | x | 21.0 | = | 673 |
| Wall | South | 192.0 | x | 0.1214 | x | 14.0 | = | 326 |
| Wall | West | 288.0 | x | 0.1214 | x | 21.0 | = | 734 |
| Wall | Northeast | 37.0 | x | 0.1214 | x | 17.0 | = | 76 |
| Roof | Horizontal | 1592.0 | x | 0.0214 | x | 45.0 | = | 1537 |
| Door | North | 20.0 | x | 0.5000 | x | 11.0 | = | 110 |
| | | TOTAL FOR OPAQUE SURFACES | | | | | | 3729 |

GLAZING CONDUCTIVE AND SOLAR HEAT GAIN:

| Description | Orientation | Area (sf) | | GLF (Btu/hr-sf) | | Heat Gain (Btu/hr) |
|---|---|---|---|---|---|---|
| Window | North | 24.0 | x | 20.1 | = | 483 |
| Window | North | 40.0 | x | 20.1 | = | 806 |
| Window | East | 18.7 | x | 43.0 | = | 804 |
| Window | Shaded | 5.3 | x | 20.1 | = | 106 |
| Window | Shaded | 48.0 | x | 20.1 | = | 967 |
| Door | South | 12.4 | x | 26.0 | = | 323 |
| Door | Shaded | 67.6 | x | 20.1 | = | 1361 |
| Window | West | 23.2 | x | 43.0 | = | 997 |
| Window | Shaded | 8.8 | x | 20.1 | = | 177 |
| Window | Northeast | 8.0 | x | 32.3 | = | 258 |
| Skylight | Horizontal | 8.0 | x | 83.4 | = | 667 |
| | TOTAL FOR GLAZING SURFACES | | | | | 6950 |

INFILTRATION: (Type: Standard)
12800 cuft x 0.36 ac/hr x 0.018 Btu/cuft-F x 23.0 = 1915

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*Figure 4-31 (cont'd). Sizing Detailed Report*

```
HVAC SIZING                                                        HVAC    Page 4
═══════════════════════════════════════════════════════════════════════════════
Project Title.......... Sample Micropas Run                Date..09/15/05 11:54:52
╔═══════════════════════════════════════════════════════════════════════════════╗
║     MICROPAS7 v7.10  File-MP7BASE  Wth-CTZ12S05  Program-FORM CF-1R           ║
║       User#-MP0101  User-Enercomp, Inc.  Run-Cardinal Orientation             ║
╚═══════════════════════════════════════════════════════════════════════════════╝


INTERNAL GAIN (Ig):                    1.00 x (  4 x   230.0 + 1600) =   2520
                              Dwelling Units     People     Appliance ─────────

                                                            SUBTOTAL    15114

DUCT HEAT GAIN: Duct Location: Attic                 0.140 x  15114  =   2116
                                                                       ─────────

                                      TOTAL HOURLY SENSIBLE HEAT GAIN    17229
                                                                       ═════════
```

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